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G-000-105.22

SITE-WIDE CHARACTERIZATION REPORT
VOLUME 2 OF 5 PART 1
AUGUST 1992

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DOE-FN/EPA
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REPORT

G-000-104.8

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SITE-WIDE CHARACTERIZATION REPORT

FERNALD ENVIRONMENTAL MANAGEMENT PROJECT
FERNALD, OHIO

REMEDIAL INVESTIGATION AND FEASIBILITY STUDY

VOLUME 2 of 5
PART I
(CONTINUED)

AUGUST 1992

U.S. DEPARTMENT OF ENERGY
FERNALD FIELD OFFICE

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4.0 DATA SUMMARY

4.1 NATURE AND EXTENT OF CONTAMINATION

This section describes the nature and extent of contamination associated with the FEMP from a site-wide perspective. The focus of the section is on presenting data sufficient to support the PBRA, is Part II of this report. This section is not intended to provide a basis for deciding among alternative remedial actions or between remediation and no action, and data interpretation is accordingly limited. The validated data and interpretation necessary to such decision making will be provided in operable unit RI reports.

4.1.1 Silos 1 through 4, Drummed Waste, and Buildings and Equipment

This section presents data on Silos 1 through 4, drummed wastes, and buildings and equipment at the FEMP. Previous studies include Silo 1, 2 and 3 sampling conducted by WEMCO (1989), tank and drum sampling done by DOE (1988), the resampling of Silos 1 and 2 conducted by ASI/IT as part of the RI/FS investigation, and buildings and equipment that were surveyed by WEMCO and ASI/IT. WEMCO sampling of the silos showed distinct differences in the contents of Silos 1 and 2 versus those of Silo 3. Silo 3 contains lower concentrations of radium and lead than Silos 1 and 2; however, Silo 3 contains higher amounts of aluminum, arsenic, potassium and sodium. Data from the resampling of Silos 1 and 2 was limited to chemical analysis for Silo 2, due to the December 1, 1991 cut-off date for data to be used in the SWCR. The silos contain both inorganics and semivolatile and volatile organic compounds, including cobalt, lead, PCBs and bis(2-ethylhexyl) phthalate. Drum sampling conducted as part of the DOE investigation found detectable levels of radionuclides and several volatile organic compounds. Radiological surveys conducted on structures and equipment on-property indicated a number of areas in the former production area with above background levels of removable and fixed alpha and combined beta-gamma activity, as well as radon and thoron.

4.1.1.1 WMCO (1989), "Feed Materials Production Center Environmental Monitoring Annual Report"

Radionuclide data from the WEMCO sampling of Silos 1, 2 and 3 are presented in Table 4-1. The most abundant radionuclides in the silos include lead-210 and isotopes of radium, thorium, and uranium. Actinium-227 and protactinium-231 were also abundant in Silo 3. Chemically, the residues in Silos 1 and 2 are mixtures of hydroxides, carbonates and sulfates. Approximately 40 to 60 percent of the waste is silicates (SiO_2); carbonates and sulfates comprise approximately 20 percent. The primary form of uranium contained in the residues is sodium uranyl carbonate (Dettorre et al., 1981). HSL analyses show that the inorganic constituents of greatest concentration in Silos 1 and 2 are barium, calcium, iron, lead and magnesium (Table 4-2). The primary inorganic constituents in Silo 3 are aluminum, calcium, iron, magnesium, potassium and sodium.

TABLE 4-1

RADIONUCLIDES DETECTED DURING WESTINGHOUSE SAMPLING OF THE CONTENTS OF SILOS 1, 2, AND 3

Radionuclide	Parameters	Silos 1 & 2	Silo 3	Radionuclide	Parameters	Silos 1 & 2	Silo 3
Ac-227	Frequency of Detection	ND[b]	11/11	Th-228	Frequency of Detection	2/13	7/11
	Range (pCi/g)	ND	234.00-1363.0		Range (pCi/g)	411.00-638.00	459.00-996.00
	Mean[a] (pCi/g)	ND	581.00		Mean (pCi/g)	285.77	589.95
Pa-231	Frequency of Detection	ND	9/9	Th-230	Frequency of Detection	13/13	10/10
	Range (pCi/g)	ND	266.00-931.00		Range (pCi/g)	8365.0-43771	21010-68759
	Mean (pCi/g)	ND	557.44		Mean (pCi/g)	28928	49164
Pb-210	Frequency of Detection	13/13	11/11	Th-232	Frequency of Detection	2/13	8/11
	Range (pCi/g)	48980-399200	454.00-6427.0		Range (pCi/g)	766.00-851.00	411.00-1451.0
	Mean (pCi/g)	122252	2616.7		Mean (pCi/g)	321.42	656.27
Ra-224	Frequency of Detection	ND	11/11	U-234	Frequency of Detection	13/13	11/11
	Range (pCi/g)	ND	64.000-453.00		Range (pCi/g)	121.00-1404.0	348.00-1935.0
	Mean (pCi/g)	ND	289.64		Mean (pCi/g)	772.62	1477.9
Ra-226	Frequency of Detection	13/13	11/11	U-235/236	Frequency of Detection	7/13	10/11
	Range (pCi/g)	657.10-192600	467.00-6435.0		Range (pCi/g)	36.100-73.900	41.700-158.00
	Mean (pCi/g)	112627	2972.5		Mean (pCi/g)	39.219	93.600
Ra-228	Frequency of Detection	ND	10/11	U-238	Frequency of Detection	13/13	11/11
	Range (pCi/g)	ND	20.000-559.00		Range (pCi/g)	45.500-1240.0	320.00-2043.0
	Mean (pCi/g)	ND	297.68		Mean (pCi/g)	704.12	1500.4

[a]If the distribution is normal or if the distribution is log-normal, the number of detects ≥ 7, and frequency of detection $\geq 50\%$, an arithmetic mean is given. If the distribution is log-normal and either the number of detects < 7 or the frequency of detection is $< 50\%$, a geometric mean is given. Details of statistical analyses are described in the Risk Assessment Work Plan Addendum (DOE 1992).
[b]Not detected.

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TABLE 4-2

CHEMICALS DETECTED DURING WESTINGHOUSE SAMPLING OF THE CONTENTS OF SILOS 1, 2, AND 3 AND RI/FS SAMPLING OF SILO 2

		Westinghouse Sampling		RI/FS Sampling
Chemical	Parameters	Silos 1 & 2	Silo 3	Silo 2
Aluminum	Frequency of Detection	12/12	11/11	2/2
	Range (mg/kg)	60.400-2570.0	10800-23700	752.00-977.00
	Mean[a] (mg/kg)	982.70	17227	
Antimony	Frequency of Detection	2/2	ND[b]	2/2
	Range (mg/kg)	6.400-7.200	ND	18-200-21.400
	Mean (mg/kg)		ND	
Arsenic	Frequency of Detection	12/12	11/11	2/2
	Range (mg/kg)	14.700-1960.0	532.00-6380.0	61.500-73.800
	Mean (mg/kg)	238.08	1952.9	
Barium	Frequency of Detection	12/12	11/11	2/2
	Range (mg/kg)	89.200-8370.0	118.00-332.00	7630.0-8048.0
	Mean (mg/kg)	3923.3	216.64	
Beryllium	Frequency of Detection	12/12	11/11	2/2
	Range (mg/kg)	0.660-6.000	10.000-39.900	1.200-1.300
	Mean (mg/kg)	1.953	24.200	
Boron	Frequency of Detection	ND	ND	2/2
	Range (mg/kg)	ND	ND	53.500-57.700
	Mean (mg/kg)	ND	ND	
Cadmium	Frequency of Detection	12/12	11/11	2/2
	Range (mg/kg)	2.100-19.100	21.500-204.00	2.000-6.700
	Mean (mg/kg)	5.150	59.755	
Calcium	Frequency of Detection	12/12	11/11	2/2
	Range (mg/kg)	2150.0-301000	21300-39900	10800-20600
	Mean (mg/kg)	32585	29373	
Chromium	Frequency of Detection	12/12	11/11	2/2
	Range (mg/kg)	12.900-165.00	139.00-560.00	35.100-73.300
	Mean (mg/kg)	51.475	288.09	
Cobalt	Frequency of Detection	12/12	10/10	2/2
	Range (mg/kg)	6.200-2430.0	1100.0-3520.0	813.00-1030.0
	Mean (mg/kg)	753.02	2104.0	
Copper	Frequency of Detection	11/11	11/11	2/2
	Range (mg/kg)	122.00-1790.0	1610.0-7060.0	301.00-332.00
	Mean (mg/kg)	375.82	2546.4	

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TABLE 4-2
(Continued)

		Westinghouse Sampling		RI/FS Sampling
Chemical	Parameters	Silos 1 & 2	Silo 3	Silo 2
Cyanide	Frequency of Detection	11/11	ND[b]	2/2
	Range (mg/kg)	0.900-4.500	ND	6.300-7.100
	Mean[a] (mg/kg)	2.117	ND	[c]
Iron	Frequency of Detection	12/12	11/11	2/2
	Range (mg/kg)	4010.0-75100	13900-67600	8710.0-15300
	Mean (mg/kg)	19051	37800	[c]
Lead	Frequency of Detection	12/12	11/11	2/2
	Range (mg/kg)	153.00-85100	646.00-4430.0	32300-34100
	Mean (mg/kg)	41263	1727.8	[c]
Magnesium	Frequency of Detection	12/12	11/11	2/2
	Range (mg/kg)	1500.0-8740.0	38200-80900	2660.0-3810.0
	Mean (mg/kg)	3939.2	58582	[c]
Manganese	Frequency of Detection	12/12	11/11	2/2
	Range (mg/kg)	33.500-403.00	2420.0-6500.0	96.200-96.400
	Mean (mg/kg)	148.64	4380.0	[c]
Mercury	Frequency of Detection	11/11	3/3	2/2
	Range (mg/kg)	0.230-2.300	0.300-0.690	0.760-0.990
	Mean (mg/kg)	0.793	0.430	[c]
Molybdenum	Frequency of Detection	ND	ND	2/2
	Range (mg/kg)	ND	ND	198.00-449.00
	Mean (mg/kg)	ND	ND	[c]
Nickel	Frequency of Detection	12/12	11/11	2/2
	Range (mg/kg)	14.600-2580.0	1200.0-6170.0	1320.0-1740.0
	Mean (mg/kg)	1128.4	2974.5	[c]
Phosphorous	Frequency of Detection	ND	ND	2/2
	Range (mg/kg)	ND	ND	623.00-1400.0
	Mean (mg/kg)	ND	ND	[c]
Potassium	Frequency of Detection	12/12	11/11	2/2
	Range (mg/kg)	37.800-492.00	1300.0-22800.	209.00-252.00
	Mean (mg/kg)	266.15	7258.2	[c]
Selenium	Frequency of Detection	11/11	11/11	2/2
	Range (mg/kg)	91.100-180.00	101.00-349.00	75.300-125.00
	Mean (mg/kg)	132.00	173.55	[c]
Silicon	Frequency of Detection	ND	ND	2/2
	Range (mg/kg)	ND	ND	721.00-746.00
	Mean (mg/kg)	ND	ND	[c]

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TABLE 4-2
(Continued)

Chemical	Parameters	Westinghouse Sampling		RI/FS Sampling
		Silos 1 & 2	Silos 3	Silo 2
Silver	Frequency of Detection	11/11	11/11	2/2
	Range (mg/kg)	5.000-23.300	9.200-23.800	11.800-16.500
	Mean[a] (mg/kg)	11.673	15.909	[c]
Sodium	Frequency of Detection	12/12	11/11	2/2
	Range (mg/kg)	226.00-13100	22900-51700	2120.0-2840.0
	Mean (mg/kg)	3910.3	36100	[c]
Thallium	Frequency of Detection	9/9	11/11	2/2
	Range (mg/kg)	0.240-1.400	3.100-73.900	0.890-0.900
	Mean (mg/kg)	0.576	19.018	[c]
Uranium	Frequency of Detection	13/13	11/11	ND[b]
	Range (mg/kg)	137.00-3717.0	738.00-4554.0	ND
	Mean (mg/kg)	2111.3	2956.1	ND
Vanadium	Frequency of Detection	12/12	11/11	2/2
	Range (mg/kg)	21.900-214.00	418.00-4550.0	269.00-325.00
	Mean (mg/kg)	131.43	1819.7	[c]
Zinc	Frequency of Detection	12/12	11/11	2/2
	Range (mg/kg)	11.200-154.00	301.00-672.00	25.300-159.00
	Mean (mg/kg)	40.292	450.00	[c]
1,4-Dioxane	Frequency of Detection	ND[b]	ND	1/2
	Range (mg/kg)	ND	ND	0.078-0.078
	Mean (mg/kg)	ND	ND	[c]
2-Butanone	Frequency of Detection	13/13	5/5	1/3
	Range (mg/kg)	7.100-21.000	9.700-16.000	0.009-0.009
	Mean (mg/kg)	11.200	13.340	0.007
4-Methyl-2-Pentanone	Frequency of Detection	4/4	ND	1/3
	Range (mg/kg)	0.870-2.700	ND	0.003-0.003
	Mean (mg/kg)	1.329	ND	0.005
Acetone	Frequency of Detection	10/10	5/5	3/3
	Range (mg/kg)	0.140-5.300	3.400-12.000	0.017-0.068
	Mean (mg/kg)	1.894	5.246	0.044
Aroclor-1248	Frequency of Detection	5/5	ND	ND
	Range (mg/kg)	1.700-7.300	ND	ND
	Mean (mg/kg)	3.520	ND	ND
Aroclor-1254	Frequency of Detection	13/13	ND	1/1
	Range (mg/kg)	0.420-10.000	ND	5.000-5.000
	Mean (mg/kg)	3.640	ND	[c]
Aroclor-1260	Frequency of Detection	1/1	ND	ND
	Range (mg/kg)	0.340-0.340	ND	ND
	Mean (mg/kg)	[c]	ND	ND

TABLE 4-2
(Continued)

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Chemical	Parameters	Westinghouse Sampling		RI/FS Sampling
		Silos 1 & 2	Silos 3	Silo 2
Bis(2-Ethylhexyl) phthalate	Frequency of Detection	12/12	1/1	1/1
	Range (mg/kg)	0.093-6.000	0.040-0.040[c]	0.330-0.330[c]
	Mean (mg/kg)	0.912		
Chloride	Frequency of Detection	ND[b]	ND	3/3
	Range (mg/kg)	ND	ND	73.700-141.00
	Mean (mg/kg)	ND	ND	96.136
Chloroform	Frequency of Detection	13/13	5/5	ND
	Range (mg/kg)	0.480-1.500	0.560-0.810	ND
	Mean (mg/kg)	0.775	0.694	ND
Chloromethane	Frequency of Detection	ND	1/1	ND
	Range (mg/kg)	ND	0.014-0.0140[c]	ND
	Mean (mg/kg)	ND		ND
Di-n-octylphthalate	Frequency of Detection	3/3	ND	ND
	Range (mg/kg)	0.045-0.820	ND	ND
	Mean (mg/kg)	0.455	ND	ND
Fluoranthene	Frequency of Detection	ND	ND	1/1
	Range (mg/kg)	ND	ND	0.064-0.064[c]
	Mean (mg/kg)	ND	ND	
Methylene chloride	Frequency of Detection	13/13	5/5	3/3
	Range (mg/kg)	0.840-6.300	1.000-2.800	0.003-0.047
	Mean (mg/kg)	2.772	1.680	0.021
Nitrate	Frequency of Detection	ND	ND	3/3
	Range (mg/kg)	ND	ND	3350.0-5110.0
	Mean (mg/kg)	ND	ND	3983.3
Oil and Grease	Frequency of Detection	ND	ND	2/2
	Range (mg/kg)	ND	ND	252.00-991.70[c]
	Mean (mg/kg)	ND	ND	
Pyrene	Frequency of Detection	ND	ND	1/1
	Range (mg/kg)	ND	ND	0.047-0.047[c]
	Mean (mg/kg)	ND	ND	
Pyridine	Frequency of Detection	ND	ND	1/2
	Range (mg/kg)	ND	ND	0.045-0.045[c]
	Mean (mg/kg)	ND	ND	
Styrene	Frequency of Detection	2/2	ND	ND
	Range (mg/kg)	0.2-0.35[c]	ND	ND
	Mean (mg/kg)		ND	ND
Sulfate	Frequency of Detection	ND	ND	3/3
	Range (mg/kg)	ND	ND	7420.0-11240
	Mean (mg/kg)	ND	ND	8983.3

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TABLE 4-2
(Continued)

Chemical	Parameters	Westinghouse Sampling		RI/FS Sampling
		Silos 1 & 2	Silos 3	Silo 2
Toluene	Frequency of Detection	10/10	5/5	3/3
	Range (mg/kg)	0.13-0.43	0.180-6.800	0.003-0.005
	Mean[a] (mg/kg)	0.207	3.398	0.004
Total Organic Carbon	Frequency of Detection	ND[b]	ND	2/2
	Range (mg/kg)	ND	ND	148.0-12204
	Mean (mg/kg)	ND	ND	[c]
Total Organic Nitrogen	Frequency of Detection	ND	ND	1/2
	Range (mg/kg)	ND	ND	260.6-260.6
	Mean (mg/kg)	ND	ND	[c]
Total Xylenes	Frequency of Detection	2/2	ND	ND
	Range (mg/kg)	0.13-0.2	ND	ND
	Mean (mg/kg)	[c]	ND	ND
Trichloroethane	Frequency of Detection	1/1	ND	ND
	Range (mg/kg)	0.12-0.12	ND	ND
	Mean (mg/kg)	[c]	ND	ND

[a]If the distribution is normal or if the distribution is log-normal, the number of detects $\geq$ 7, and frequency of detection $\geq$ 50%, an arithmetic mean is given. If the distribution is log-normal and either the number of detects < 7 or the frequency of detection is < 50%, a geometric mean is given. Details of statistical analyses are described in the Risk Assessment Work Plan Addendum (DOE 1992).
[b]Not detected.
[c]Not applicable if sample size is $\leq$ 2.

PCBs (Aroclor 1248 and 1254) were detected in samples from Silos 1 and 2 at concentrations ranging from 420 to 10,000 µg/kg (Table 4-2). No PCBs were detected in Silo 3. Organic constituents observed in Silo 3 samples included 2-butanone, acetone, bis(2-Ethylhexyl) phthalate, chloroform, chloromethane, methylene chloride, and toluene.

4.1.1.2 FEMP Remedial Investigation/Feasibility Study

Limited RI/FS data from silo sampling was available as of December 1, 1991, specifically chemical data for Silo 2. The complete data will be provided in the RI report for Operable Unit 4.

A number of inorganic constituents were detected at concentrations above background. The most abundant of these relative to background included cobalt, lead, nickel, and selenium (Table 4-2). Volatile organic compounds were detected in levels ranging from 3 µg/kg for 4-methyl-2-pentanone to 5000 µg/kg of aroclor-1254. Semivolatile compounds detected in Silo 2 included fluoranthene and bis(2-ethylhexyl) phthalate.

4.1.1.3 "FMPC Sampling and Analysis Report," DOE (1988)

Samples were collected as either grab samples from individual drums or composite samples taken from several drums or tanks. Samples showing detectable concentrations of radionuclides were collected from drums containing depleted uranium from the Plant 6 water treatment process and from Waste Pit 2 tanks (Tables 4-3A, 4-3B). RCRA metals detected in drum and tank sampling are listed in Table 4-3B. A grab sample collected from drum 9 on the north pad of Plant 6 contained a number of volatile organic compounds (Table 4-3C).

4.1.1.4 Buildings and Equipment

The results of the structures and equipment radiological surveys conducted by the on-property IRS&T are presented in Table 4-4. For each category of reported data, the average of all the values, the maximum, the minimum, and the sample size are reported. Within each component four categories have been established to differentiate between sample locations:

- Accessible represents any accessible surface (i.e. equipment, walls, desks, etc.)
- Floors represent drain grates, metal platforms, concrete, etc.
- Sumps represent dikes and sumps
- Unaccessible represents overhead structures or any areas unaccessible.

By separating survey values into these categories, a more detailed assessment of contamination can be made.

Results from the structures/equipment surveys showed that the highest removable alpha was 46,300 disintegrations per minute (DPM) in an accessible sample from the special products plant. Both an

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TABLE 4-3A
Radionuclides Detected in Drum and Tank Sampling (DOE, 1988)

(Measurements are in pCi/g)

	Plant 1 Drums	Plant 6 Drums	Plant 8 Drums	Plant 9 Drums	Plant 2/3 Tanks	Plant 8 Tanks	Pit 2 Tanks
Np-237							0.24
Pu-238							0.06
Pu-241/242							0.12
Ra-226							1.93-65.21
Ra-228							2.31-47.88
Th-232							17
U-235		161		3200			
U-238		43000		1.2×10^6			
Total U*							635-8570

* Units are in mg/kg.

TABLE 4-3B
RCRA Metals Detected During Drum and Tank Sampling (DOE, 1988)

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(Measurements are in mg/kg)

	Plant 1 Drums	Plant 6 Drums	Plant 8 Drums	Plant 9 Drums	Plant 2/3 Tanks	Plant 8 Tanks	Pit 2 Tanks
Barium	2.29		0.11-44.9		7.28-11.5	6.61-20.7	0.08-0.4
Cadmium							0.08
Chromium	0.03		0.03-0.16	0.03		0.03-0.06	0.22
Mercury			0.03-0.43				
Lead	1.97					0.30-0.71	

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Table 4-3C
Chemicals Detected During Drum and Tank Sampling (DOE, 1988)

(Measurements are in µg/kg)

	Plant 1 Drums	Plant 6 Drums	Plant 8 Drums	Plant 9 Drums	Plant 2/3 Tanks	Plant 8 Tanks	Pit 2 Tanks
1,1-Dichloroethane		300					
1,1-Dichloroethene		120					
1,1,1-Trichloroethane		7400					7
2-Butanone		1800					
2-Hexanone		2300					
4-Methyl-2 Pentanone		770					
Acetone		45-2100					20
Aroclor-1254*			1.1				
Chloroform		20-64					
Methylene Chloride		24-150					
Tetrachloroethene		550					
Toluene		160					
Trichloroethene		49					
Total Xylenes		8					

* Units are in mg/kg.

TABLE 4-4
Radiological Surveys of FEMP Structures and Equipment

Buildings	Building Number	Building Letter	Category	Alpha Removable (DPM) Average	Alpha Removable (DPM) Minimum Value	Alpha Removable (DPM) Maximum Value	Alpha Removable (DPM) Sample Size	Alpha Fixed (1000 DPM) Average	Alpha Fixed (1000 DPM) Minimum Value	Alpha Fixed (1000 DPM) Maximum Value	Alpha Fixed (1000 DPM) Sample Size	Beta-Gamma Removable (DPM) Average	Beta-Gamma Removable (DPM) Minimum Value	Beta-Gamma Removable (DPM) Maximum Value	Beta-Gamma Removable (DPM) Sample Size	Beta-Gamma Fixed (1000 DPM) Average	Beta-Gamma Fixed (1000 DPM) Minimum Value	Beta-Gamma Fixed (1000 DPM) Maximum Value	Beta-Gamma Fixed (1000 DPM) Sample Size	Date
Preparation Plant		1	A	Accessible	241.94	41	638	18	NA	NA	NA	NA	537.50	70	1770	18	NA	NA	NA	NA	Mar 91
				Floor	146.19	15	1140	62	NA	NA	NA	NA	199.92	5	1120	62	NA	NA	NA	NA	Mar 91
Plant 1 Storage Building		1	B	No Data																	
Plant 1 Ore Silos		1	C	Accessible	497.49	6	12200	41	60.00	60	60	1	242.91	2	5920	42	NA	NA	NA	NA	Feb-Apr 91
				Floor	5585.09	6	23100	85	108.00	100	140	5	2873.40	2	14400	85	NA	NA	NA	NA	Feb-Apr 91
				Sump	1402.67	172	4860	9	NA	NA	NA	NA	629.22	87	2180	9	NA	NA	NA	NA	Feb 91
				Unaccess.	423.00	76	731	4	NA	NA	NA	NA	208.50	55	286	4	NA	NA	NA	NA	Feb 91
Ore Refinery Plant		2	A	Accessible	533.40	42	10800	178	9.32	0.2	100	134	1540.95	38	50200	179	232.03	0.5	1599	176	Jun-Aug 91
				Floor	215.57	42	42200	675	7.85	0.2	100	673	504.55	38	115000	675	85.38	0.7	999	676	Jun-Aug 91
				Unaccess.	456.13	51	2350	15	4.20	0.3	40	15	1258.93	84	5010	15	81.34	8.7	289	15	Jun-Aug 91
General/Refinery Sump Control Building		2	B	Accessible	78.07	50.9	433	31	0.86	0.1	5	19	138.64	53.8	1390	31	40.44	0.1	220	23	Jul 91
				Floor	50.90	50.9	50.9	46	0.66	0.1	7	32	54.30	53.8	77	46	6.53	0.2	59	40	Jul 91
Bulk Lime Handling Building		2	C	Accessible	41.95	41.9	42	2	0.18	0.1	0.4	6	46.70	36.4	55	2	1.44	0.1	5.2	13	Jun 91
				Floors	41.93	41.9	42	4	0.17	0.1	0.4	7	36.40	36.4	36.4	4	9.08	0.2	52	13	Jun 91
Metal Dissolver Building		2	D	Accessible	70.42	42	156	19	4.22	0.2	21	19	128.98	36.4	323	19	39.11	1.6	108	18	Mar/Jun 91
				Floor	202.91	41	1890	76	8.57	0.2	70	46	552.01	36.4	8430	76	70.54	0.5	398.6	46	Jun 91
NFS Storage & Pump House		2	E	No Data																	
Cold Side Ore Conveyer		2	F	No Data																	
Hot Side Ore Conveyor		2	G	No Data																	
Conveyor Tunnel (From Plant 1)		2	H	No Data																	
Maintenance Building		3	A	Accessible	59.77	19.8	288	45	0.93	0.1	4.6	58	107.98	23.8	755	45	13.59	0.1	89.4	60	Jun-Jul 91
				Floor	61.21	19.8	340	27	0.51	0.1	3.3	55	100.93	23.8	551	27	11.53	0.1	69.4	64	Jun-Jul 91
				Unaccess.	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	1.00	1	1	1	Jun-Jul 91
Ozone Building		3	B	Accessible	84.42	42	261	12	2.39	0.4	16	15	132.83	55	288	12	18.37	2.5	149.5	15	Jun 91
				Floor	93.92	42	191	12	1.35	0.5	2.1	25	183.92	55	370	12	17.04	1.3	199.5	25	Jun 91
NAR Control House		3	C	Accessible	31.39	19.8	50.9	26	0.24	0.1	0.7	14	39.92	23.8	59	27	4.69	0.1	24.4	37	Jun-Jul 91
				Floor	27.21	19.8	50.9	21	0.34	0.1	1	16	35.41	23.8	53.8	22	2.43	0.1	47.4	78	Jun-Jul 91
NAR Towers		3	D	All Fixed Beta-Gamma values greater than 25,000 DPM Fixed																	
Hot Raffinate Building		3	E	Accessible	184.24	51	1296	37	9.96	0.4	31	36	316.28	67	4250	37	89.48	0.2	199	36	Jun 91
				Floor	120.03	51	840	80	5.56	0.2	30	81	225.43	61	4100	80	51.02	0.4	379	81	Jun 91
Harshaw System		3	F	Accessible	105.75	51	209	4	0.57	0.2	1.1	15	255.60	84	673	5	18.83	0.7	69.5	16	Jun 91
				Floor	NA	NA	NA	NA	0.28	0.1	0.6	6	148.00	148	148	1	3.49	0.7	10.5	9	Jun 91
Refrigeration Building		3	G	Accessible	31.91	19.8	121	11	0.50	0.1	2.3	10	96.11	23.8	475	11	109.40	0.1	900	9	Jun 91
				Floor	19.80	19.8	19.8	3	1.30	0.2	4.1	7	43.93	23.8	73	3	8.84	1.4	29.4	7	Jun 91
Refinery Sump		3	H	No Data																	
Combined Raffinate Tanks		3	J	Accessible	384.48	51.6	1870	8	NA	NA	NA	NA	810.25	52	3180	8	NA	NA	NA	NA	Jun 91
				Floor	267.53	51.6	2400	16	NA	NA	NA	NA	585.47	43.5	5560	16	NA	NA	NA	NA	Jun 91
				Sump	136.50	114	159	2	NA	NA	NA	NA	303.50	283	324	2	NA	NA	NA	NA	Jun 91
				Unaccess.	154.80	51.6	312	4	NA	NA	NA	NA	164.38	43.5	338	4	NA	NA	NA	NA	Jun 91
Old Cooling Water Tower		3	K	No Data																	
Electrical Power Center Building		3	L	No Data																	
Green Salt Plant		4	A																		
First Floor - Elev. 580				Accessible	2155.64	19.7	18100	67	NA	NA	NA	NA	13263.07	15.3	143000	67	NA	NA	NA	NA	Oct-Nov 91
				Floor	778.60	19.7	26200	91	NA	NA	NA	NA	2621.25	15.3	89200	91	NA	NA	NA	NA	Oct-Nov 91
				Unaccess.	4366.11	51.6	16200	33	NA	NA	NA	NA	13529.09	51	49500	33	NA	NA	NA	NA	Oct-Nov 91
Elev 588				Accessible	4982.48	278	28200	25	NA	NA	NA	NA	21661.96	682	109000	25	NA	NA	NA	NA	Nov 91
				Floor	796.38	82	3670	16	NA	NA	NA	NA	3138.63	156	19800	16	NA	NA	NA	NA	Nov 91
				Unaccess.	2604.22	362	5520	9	NA	NA	NA	NA	6253.00	829	16600	9	NA	NA	NA	NA	Nov 91
Second Floor - Elev 597				Accessible	2965.30	53	31900	95	NA	NA	NA	NA	16037.43	129	176000	95	NA	NA	NA	NA	Nov 91
				Floor	1212.18	53	11800	75	NA	NA	NA	NA	6071.92	52	48800	75	NA	NA	NA	NA	Nov 91
Elev 605				Accessible	1432.43	110	3440	14	NA	NA	NA	NA	3589.93	198	9990	14	NA	NA	NA	NA	Nov 91
				Floor	612.82	73	2070	26	NA	NA	NA	NA	1064.92	170	4790	26	NA	NA	NA	NA	Nov 91
Elev 610				Accessible	1429.44	54.4	12200	27	NA	NA	NA	NA	3039.26	37	26700	27	NA	NA	NA	NA	Nov 91
				Floor	292.47	54.4	1070	32	NA	NA	NA	NA	526.25	37	1690	32	NA	NA	NA	NA	Nov 91
				Unaccess.	10951.00	11000	11000	1	NA	NA	NA	NA	28138.00	28100	28100	1	NA	NA	NA	NA	Nov 91
Third Floor - Elev 619				Accessible	623.54	54.4	3530	54	NA	NA	NA	NA	1672.26	37	17600	54	NA	NA	NA	NA	Nov 91
				Floor	270.03	54	3330	103	NA	NA	NA	NA	541.19	37	9650	103	NA	NA	NA	NA	Nov 91
				Unaccess.	4213.00	1170	9020	3	NA	NA	NA	NA	9420.67	2920	20000	3	NA	NA	NA	NA	Nov 91
Fourth Floor - Elev 629				Accessible	2210.40	55	8840	15	NA	NA	NA	NA	6211.93	87	18400	15	NA	NA	NA	NA	Nov 91
				Floor	985.05	26	8020	125	NA	NA	NA	NA	2342.90	46	26600	125	NA	NA	NA	NA	Nov 91
Plant 4 Warehouse		4	B	Accessible	312.24	46	1680	30	NA	NA	NA	NA	949.17	37	3360	30	NA	NA	NA	NA	Nov 91
Plant 4 Maintenance Building		4	C	Floor	54.40	54.4	54.4	20	NA	NA	NA	NA	38.60	37	69	20	NA	NA	NA	NA	Nov 91
Metals Production Plant		5	A																		
First Floor				Accessible	678.97	6	125	860	4.46	0.16	200	841	6536.78	13	187000	867	197.32	0.16	4000	882	Feb-Sep 91
				Floor	296.63	6	5620	1465	3.37	0.1	200	1490	2006.86	1	109000	1487	147.56	0.16	4000	1498	Feb-Sep 91
				Sump	2574.00	199	4950	2	2.00	2	2	1	81114.50	1900	160000	2	755.00	110	1400	2	Feb-Sep 91
				Unaccess.	1655.92	42	4320	13	9.93	0.2	32	13	17534.69	48	54300	13	1927.52	1.3	4000	13	Feb-Sep 91
Second Floor				Accessible	598.86	43	10400	345	6.77	0.1	44	348	3063.02	46	74600	345	62.29	0.6	1000	290	Feb-Sep 91
				Floor	360.94	1.2	3490	654	7.12	0.2	48	653	1471.42	1.4	21500	655	122.54	0.4	1800	512	Feb-Sep 91
Metals Production Plant (Cont.)		5	A	Unaccess.	978.42	42	6840	24	15.57	0.2	45	24	4328.42	64	38300	24	171.13	1.8	600	20	Feb-Sep 91
Plant 5 Ingot Pickling		5	B	No Data																	
Plant 5 Electrical Substation		5	C	No Data																	

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West Derby Breakout/Slag Milling	5	D	No Data																	
Plant 5 Filter Building	5	E	No Data																	
Plant 5 Covered Storage Pad	5	F	No Data																	
Plant 5 Ingot Storage Shelter	5	G	No Data																	
Metals Fabrication Plant	6	A	Accessible	1251.49	6	34100	1605	NA	NA	NA	NA	21767.32	1	808000	1615	187.67	0.5	2600	1314	Jul-Sep 91
			Floor	705.31	6	21300	779	NA	NA	NA	NA	7591.74	38	296000	782	141.37	0.5	1500	609	Jul-Sep 91
			Sump	1836.73	6	14100	30	NA	NA	NA	NA	80042.83	287	783000	30	331.05	1	1700	30	Jul-Sep 91
			Unaccess.	394.57	136	734	14	NA	NA	NA	NA	2730.64	612	5880	14	90.00	90	90	1	Jul-Sep 91
Plant 6 Covered Storage Area	6	B	No Data																	
Plant 6 Electrostatic Precipitator (South)	6	C	No Data																	
Plant 6 Electrostatic Precipitator (Central)	6	D	No Data																	
Plant 6 Electrostatic Precipitator (North)	6	E	No Data																	
Plant 6 Salt Oil Heat Treat Building	6	F	No Data																	
Plant 6 Sump Building	6	G	No Data																	
Plant 7	7	A	Accessible	719.05	15	4780	65	NA	NA	NA	NA	2498.72	29	16600	65	NA	NA	NA	NA	Mar 91
			Floor	370.10	15	26300	178	NA	NA	NA	NA	864.46	24	29800	178	NA	NA	NA	NA	Mar 91
Plant 7 Overhead Crane	7	B	No Data																	
Recovery Plant	8	A	Accessible	503.42	1.6	23000	646	2.90	0.2	120	837	1147.19	2.1	42000	646	66.25	1	1400	845	Oct-Nov 91
			Floor	332.92	12.4	26000	1168	1.76	0.2	60	1684	551.36	1.3	10000	1168	44.90	0.2	1000	1684	Oct-Nov 91
			Sump	358.62	232	1000	11	1.59	0.2	20	34	561.00	348	2200	11	31.82	1	350	34	Oct-Nov 91
Plant 8 Maintenance Building	8	B	Accessible	19.00	19	19	2	0.17	0.1	0.2	3	26.00	26	26	2	5.83	2.5	8	3	Jun 91
			Floor	19.00	19	19	3	0.31	0.1	0.5	7	37.67	30	49	3	4.16	0.6	9	7	Jun 91
Rotary Kiln/Drum Reconditioning	8	C	See Plant 8A																	
Plant 8 Railroad Filter Building	8	D	No Data																	
Drum Conveyor Shelter	8	E	No Data																	
Plant 8 Old Drum Washer	8	F	No Data																	
Special Products Plant	9	A	Accessible	2875.31	6	46300	487	NA	NA	NA	NA	36338.03	8	706000	486	842.70	1	1800	421	May-Jul 91
			Floor	766.70	6	41700	450	NA	NA	NA	NA	8696.30	30	600000	440	230.84	1	8570	438	May-Jul 91
			Sump	5886.35	23	28300	37	NA	NA	NA	NA	86088.97	48	452000	37	706.11	30	2000	36	May-Jul 91
			Unaccess.	3699.33	533	6524	3	NA	NA	NA	NA	19174.33	1711	45100	3	NA	NA	NA	NA	May-Jul 91
Plant 9 Sump Treatment Facility	9	B	No Data																	
Plant 9 Dust Collector	9	C	No Data																	
Plant 9 Substation	9	D	No Data																	
Plant 9 Cylinder Shed	9	E	No Data																	
Electrostatic Precipitator	9	F	No Data																	
Boiler Plant	10	A	Accessible	21.55	16.3	49.5	46	NA	NA	NA	NA	32.49	17.4	220	46	NA	NA	NA	NA	May-Jun 91
			Floor	29.68	16	76	120	NA	NA	NA	NA	27.67	17.4	158	120	NA	NA	NA	NA	May-Jun 91
Boiler Plant Maintenance	10	B	Accessible	30.40	14	392	45	NA	NA	NA	NA	124.32	18.8	2350	45	NA	NA	NA	NA	Mar 91
			Floor	23.69	14	234	29	NA	NA	NA	NA	42.43	18.8	620	29	NA	NA	NA	NA	Mar 91
			Sump	24.00	24	24	1	NA	NA	NA	NA	18.80	18.8	18.8	1	NA	NA	NA	NA	Mar 91
Wet Salt Storage Bin	10	C	No Data																	
Cont. Oil/Graphit Burn Pad	10	D	No Data																	
Service Building	11																			
First Floor			Accessible	27.17	6	99	86	0.16	0.1	0.7	73	29.33	4	236	87	0.56	0.1	6.6	99	Jun-Jul 91
			Floor	29.81	6	235	112	0.24	0.1	1.8	60	33.12	4	404	114	1.07	0.05	100	222	Jun-Jul 91
			Unaccess.	39.63	19.1	51.8	7	0.42	0.1	1.1	5	30.34	16.7	36.4	7	2.03	0.15	6	5	Jun-Jul 91
Second Floor			Accessible	23.14	17.7	63	197	0.16	0.1	1.4	157	22.75	14.1	110	196	0.66	0.1	10.5	455	Jun-Jul 91
			Floor	22.88	17.7	50.9	195	0.18	0.1	1	144	20.98	14.1	119	195	0.68	0.1	19.5	439	Jun-Jul 91
			Sump	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.10	0.1	0.1	1	Jun-Jul 91
			Unaccess.	19.20	19.2	19.2	5	NA	NA	NA	NA	15.30	15.3	15.3	5	0.44	0.1	2.7	68	Jun-Jul 91
Main Maintenance Building	12	A																		
First Floor			Accessible	106.24	19.8	5510	303	0.67	0.1	20	473	199.14	20.1	18000	310	9.63	1	319	526	Sep 91
			Floor	59.06	19.8	249	449	0.34	0.1	4.3	978	72.94	5.1	15400	454	3.25	1	99.3	1046	Sep 91
Second Floor			Accessible	49.31	47.6	63	9	0.21	0.2	0.5	21	108.33	40.5	438	9	1.21	1	5.5	70	Sep 91
			Floor	47.60	47.6	47.6	10	0.20	0.2	0.2	8	40.50	40.5	40.5	10	1.15	1	7	96	Sep 91
Cylinder Storage Building	12	B	No Data																	
Lumber Storage Building	12	C	No Data																	
Pilot Plant Wet Side	13	A	Accessible	929.89	177	3630	9	NA	NA	NA	NA	766.56	111	2770	9	NA	NA	NA	NA	Apr 91
			Floor	582.36	125	1250	11	NA	NA	NA	NA	684.91	42	2680	11	NA	NA	NA	NA	Apr 91
Pilot Plant Maintenance Building	13	B	Floor	30.78	13.1	58	8	NA	NA	NA	NA	58.25	21	118	8	NA	NA	NA	NA	Jan 91
Sump Pump House	13	C	Accessible	1078.83	32	4640	6	242.00	10	1000	5	2574.50	20	11200	6	110.00	50	250	5	Mar 91
			Floor	363.26	58	941	19	228.33	20	1000	6	628.84	52	3360	19	308.33	200	500	6	Mar 91
			Unaccess.	181.20	67	257	5	2.40	1	5	5	279.80	71	396	5	47.33	2	100	3	Mar 91
Pilot Plant Thorium Tank Farm	13	D	Accessible	32.00	32	32	1	NA	NA	NA	NA	20.00	20	20	1	NA	NA	NA	NA	Apr 91
			Floor	268.46	58	629	13	NA	NA	NA	NA	441.92	52	1660	13	NA	NA	NA	NA	Apr 91

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Administration Building	14	A																		
First Floor			Accessible	21.41	12.9	48.6	114	0.14	0.1	2.5	111	20.84	12	51.9	116	0.38	0.1	17.7	243	Jul 91
			Floor	20.74	12.9	57.8	97	0.10	0.1	0.2	92	21.33	12	51.9	98	0.36	0.1	6.8	322	Jul 91
Second Floor			Accessible	23.36	19.2	58	18	0.26	0.1	1	18	36.98	14	162	18	0.83	0.1	25.4	80	Jul 91
			Floor	19.08	18.7	19.2	4	0.17	0.1	0.3	3	18.08	14.1	30	4	0.37	0.1	3	80	Jul 91
Building 14 EOC Generator Set	14	B	No Data																	
Laboratory	15		Accessible	124.28	4	30400	1552	2.47	0.6	80	281	177.60	4	23700	1556	13.17	0.8	1000	1059	Mar-Nov 91
			Floor	60.28	4	1438	553	1.12	0.2	4.6	31	70.91	4	3990	559	9.74	0.1	400	404	Mar-Nov 91
			Unaccess.	69.51	52.2	229	59	NA	NA	NA	NA	100.47	40.7	773	59	NA	NA	NA	NA	Mar-Nov 91
Main Electrical Station	16	A	No Data																	
Electrical Substation	16	B	No Data																	
Electrical Panels & Transformer	16	C	No Data																	
Main Electrical Switch House	16	D	No Data																	
Main Electrical Transformers	16	E	No Data																	
Trailer Substation #1	16	F	No Data																	
Trailer Substation #2	16	G	No Data																	
BDN Surge Lagoon	18	A	No Data																	
General Sump	18	B	Accessible	445.85	66	1110	13	NA	NA	NA	NA	620.00	66	1780	13	NA	NA	NA	NA	Apr 91
			Floor	172.54	24	602	13	NA	NA	NA	NA	398.00	48	1820	13	NA	NA	NA	NA	Apr 91
			Unaccess.	332.50	24	543	4	NA	NA	NA	NA	655.50	25	1270	4	NA	NA	NA	NA	Apr 91
Coal Pile Runoff Basin	18	C	No Data																	
Biodenitrification Towers	18	D	Accessible	51.60	51.6	51.6	13	NA	NA	NA	NA	42.50	42.5	42.5	13	NA	NA	NA	NA	Jun 91
			Floor	52.02	51.6	75.6	57	NA	NA	NA	NA	45.52	42.5	75.5	57	NA	NA	NA	NA	Jun 91
Storm Water Retention Basin	18	E	No Data																	
Clearwell Pump House	18	G	No Data																	
BDN Effluent Treatment Facility	18	H	No Data																	
Methanol Tank	18	J	No Data																	
Low Nitrate Tank	18	K	No Data																	
High Nitrate Tank	18	L	No Data																	
High Nitrate Storage Tank	18	M	No Data																	
Main Metal Tank Farm	19	A	Accessible	19.70	19.7	19.7	1	NA	NA	NA	NA	15.30	15.3	15.3	1	NA	NA	NA	NA	Nov 91
			Floor	19.70	19.7	19.7	9	NA	NA	NA	NA	15.30	15.3	15.3	9	NA	NA	NA	NA	Nov 91
Pilot Plant Ammonia Tank Farm	19	B	No Data																	
Tank Farm Control House	19	C	No Data																	
Old North Tank Farm	19	D	No Data																	
Pump Station & Power Center	20	A	No Data																	
Water Plant	20	B	Accessible	12.49	11.6	32	38	NA	NA	NA	NA	18.96	18.1	30	38	NA	NA	NA	NA	Apr 91
			Floor	12.70	11.6	24	35	NA	NA	NA	NA	18.69	18.1	30	35	NA	NA	NA	NA	Apr 91
			Unaccess.	15.00	15	15	2	NA	NA	NA	NA	18.10	18.1	18.1	2	NA	NA	NA	NA	Apr 91
Cooling Towers	20	C	No Data																	
Elevated Potable Storage Tank	20	D	No Data																	
Well House #1	20	E	No Data																	
Well House #2	20	F	No Data																	
Well House #3	20	G	No Data																	
Process Water Storage Tank	20	H	No Data																	
Gas Meter Building	22	A	No Data																	
Storm Sewer Lift Station	22	B	No Data																	
Truck Scale	22	C	No Data																	
Scale House & Weigh Scale	22	D	No Data																	
Utility Trench to Pit ARea	22	E	No Data																	
Meteorological Tower	23		No Data																	
Railroad Scale House	24	A	No Data																	
Railroad Engine House	24	B	No Data																	
Chlorination Building	25	A	No Data																	
M.H. #175/Eff. Line/Sampling Bldg.	25	B	Accessible	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	1.00	1	1	1	Jun 91
			Floor	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	1.00	1	1	1	Jun 91
Sewage Lift Station Building	25	C	No Data																	
U.V. Disinfection Building	25	D	Accessible	173	173	173	1	NA	NA	NA	NA	179	179	179	1	2.07	1	8.5	7	Jun 91
			Floor	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	1	1	1	1	Jun 91
Digester & Control Building	25	E	Accessible	21.93	19	40	14	NA	NA	NA	NA	48.36	15	190	14	2.93	1	8	14	May 91
			Floor	22.45	19	57	11	NA	NA	NA	NA	25.18	15	127	11	3.55	1	25	11	May 91
Sludge Drying Beds	25	F	Floor	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	17.67	3	26	6	May 91
Primary Settling Basins	25	G	No Data																	
Trickling Filters	25	H	No Data																	
Pump House-HP Fire Protection	26	A	No Data																	
Elevated Water Storage Tank	26	B	No Data																	
Main Electrical Strainer House	26	C	No Data																	
Security Building	28	A	Accessible	39.50	39.5	39.5	5	0.10	0.1	0.1	3	42.70	42.7	42.7	5	0.54	0.1	1.6	14	JUL 91
			Floor	39.00	18.7	39.5	42	0.17	0.1	0.5	43	42.12	14.1	47	42	0.95	0.1	7.5	57	JUL 91
Human Resources Building	28	B	Accessible	27.61	18.7	39.5	28	0.16	0.1	1	24	26.36	14.1	42.7	28	0.27	0.1	0.7	39	JUL 91
			Floor	23.59	18.7	39.5	17	0.15	0.1	0.5	16	18.64	14.1	42.7	17	0.40	0.1	2.3	55	JUL 91
Guard Post on South End of 'D' Street	28	C	No Data																	

TABLE 4-4
Radiological Surveys of FEMP Structures and Equipment

Buildings	Building Number	Building Letter	Category	Alpha Removable (DPM) Average	Alpha Removable (DPM) Minimum Value	Alpha Removable (DPM) Maximum Value	Alpha Removable (DPM) Sample Size	Alpha Fixed (1000 DPM) Average	Alpha Fixed (1000 DPM) Minimum Value	Alpha Fixed (1000 DPM) Maximum Value	Alpha Fixed (1000 DPM) Sample Size	Beta-Gamma Removable (DPM) Average	Beta-Gamma Removable (DPM) Minimum Value	Beta-Gamma Removable (DPM) Maximum Value	Beta-Gamma Removable (DPM) Sample Size	Beta-Gamma Fixed (1000 DPM) Average	Beta-Gamma Fixed (1000 DPM) Minimum Value	Beta-Gamma Fixed (1000 DPM) Maximum Value	Beta-Gamma Fixed (1000 DPM) Sample Size	Date
Guard Post on West End of 2nd Street	28	D	No Data																	
Chemical Warehouse	30	A	Accessible	40.03	15	126	38	NA	NA	NA	NA	72.66	20	231	38	NA	NA	NA	NA	Apr 91
			Floor	48.34	15	279	71	NA	NA	NA	NA	67.13	20	712	71	NA	NA	NA	NA	Apr 91
Drum Storage Warehouse	30	B	Accessible	94.38	67	172	8	NA	NA	NA	NA	191.00	54	500	8	NA	NA	NA	NA	Oct 91
			Floor	67.00	67	67	2	NA	NA	NA	NA	83.50	72	95	2	NA	NA	NA	NA	Oct 91
Old Ten Ton Scale	30	C	No Data																	
Engine House/Garage	31	A	Accessible	52.44	52.2	61	37	NA	NA	NA	NA	79.86	40	214	37	12.05	5	150	37	Oct 91
			Floor	52.20	52.2	52.2	53	NA	NA	NA	NA	43.46	40	120	53	9.87	1	100	53	Oct 91
			Sump	70.00	70	70	1	NA	NA	NA	NA	135.00	135	135	1	25.00	25	25	1	Oct 91
Old Truck Scale	31	B	No Data																	
Magnesium Storage Building	32	A	No Data																	
Building 32 Covered Loading Dock	32	B	No Data																	
Pilot Plant Annex	37		Accessible	51.37	13.3	314	25	NA	NA	NA	NA	88.55	10	369	25	NA	NA	NA	NA	Apr 91
			Floor	43.89	13.3	296	35	NA	NA	NA	NA	95.61	15	654	35	NA	NA	NA	NA	Apr 91
Propane Storage	38	A	No Data																	
Cylinder Filling Station	38	B	No Data																	
Incinerator Building	39	A	Accessible	75.67	53	121	3	8.53	0.1	25	3	136.67	72.5	265	3	139.05	0.5	799.5	6	Jun 91
			Floors	53.00	53	53	5	0.66	0.1	2.1	26	71.40	67	72.5	5	18.00	2	79.5	29	Jun 91
Waste Oil Decant Shelter	39	B	No Data																	
Incinerator Sprinkler Riser House	39	C	No Data																	
Sewage Treatment Plant Incinerator	39	D	Accessible	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	1000.00	1000	1000	1	Sep 91
			Floor	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	179.29	20	800	14	Sep 91
			Unaccess.	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	150.00	150	150	1	Sep 91
Rust Engineering Building	45	A	Accessible	25.77	9.7	79	100	0.50	0.5	0.5	2	23.03	9.5	135	100	1.00	0.32	2	67	Jun-Oct 91
			Floor	28.39	9.7	244	96	NA	NA	NA	NA	35.89	9.5	886	96	12.11	1	250	74	Jun-Oct 91
Utility Shed East of Rust Trailers	45	B	No Data																	
Heavy Equipment Building	46		Accessible	60.18	52.6	62	88	NA	NA	NA	NA	47.75	39.2	49.8	88	5.92	5	70	88	Oct 91
			Floor	59.85	52.6	62	201	NA	NA	NA	NA	47.37	39.2	49.8	201	8.00	5	100	201	Oct 91
Six to Four Reduction Facility #2	51		No Data																	
			Floor	19.00	19	19	12	NA	NA	NA	NA	17.00	17	17	12	1.00	1	1	12	Sep 91
Health and Safety Building	53	A																		
Basement			Accessible	NA	NA	NA	NA	0.2	0.2	0.2	88	NA	NA	NA	NA	1	1	1	88	Aug 91
			Floor	NA	NA	NA	NA	0.2	0.2	0.2	160	NA	NA	NA	NA	1	1	1	160	Aug 91
First Floor			Accessible	18.00	18	18	2	0.20	0.2	0.2	86	18.45	16.9	20	2	0.99	0.2	1	89	Aug 91
			Floor	22.37	18	66	11	0.20	0.2	0.2	177	46.94	15.2	289	9	0.91	0.1	1.9	203	Aug 91
			Unaccessib	NA	NA	NA	NA	0.20	0.2	0.2	3	NA	NA	NA	NA	1.00	1	1	3	Aug 91
Second Floor			Accessible	127.50	19	523	6	0.65	0.1	1.5	6	180.00	26	751	6	0.46	0.1	3.5	80	Aug 91
			Floor	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.25	0.1	1.6	35	Aug 91
In-Vivo Building	53	B	Accessible	19.00	19	19	43	NA	NA	NA	NA	17.00	17	17	43	1.00	1	1	43	Sep 91
Six to Four Reduction Facility #1	54	A	Accessible	197.96	13.3	929	25	NA	NA	NA	NA	572.01	18.3	3450	25	NA	NA	NA	NA	Apr 91
			Floor	103.62	13.3	741	35	NA	NA	NA	NA	204.79	18.3	1370	35	NA	NA	NA	NA	Apr 91
Pilot Plant Shelter	54	B	No Data																	
Pilot Plant Dissociator Shelter	54	C	No Data																	
Slag Recycling Building	55	A	Accessible	167.97	67	662	36	NA	NA	NA	NA	1599.25	258	10700	36	81.67	1	500	36	Dec 90
			Floor	121.59	33	334	32	NA	NA	NA	NA	740.44	113	2230	32	60.17	1	700	32	Dec 90
Slag Recycling Pit/Elevator	55	B	Accessible	178.98	15	955	40	NA	NA	NA	NA	1624.48	118	5100	40	5.86	3	950	32	Dec 90
			Floor	91.50	7	412	26	NA	NA	NA	NA	1620.19	95	26900	26	44.67	1	115	24	Dec 90
CP Storage Warehouse	56	A	Floor	39.50	39.5	39.5	14	NA	NA	NA	NA	42.70	42.7	42.7	14	NA	NA	NA	NA	Jul 91
Storage Shed (West)	56	B	No Data																	
Storage Shed (East)	56	C	No Data																	
Quonset Hut #1	60		No Data																	
Quonset Hut #2	61		No Data																	
Quonset Hut #3	62		No Data																	
KC-2 Warehouse	63		No Data																	
Thorium Warehouse	64		No Data																	
(Old) Plant 5 Warehouse	65		No Data																	
Drum Recondition Building	66		Accessible	152.00	152	152	1	NA	NA	NA	NA	547.00	547	547	1	NA	NA	NA	NA	Jul 91
			Floor	52.13	39.5	63	8	NA	NA	NA	NA	114.34	42.7	224	8	NA	NA	NA	NA	Jul 91
Plant 1 Thorium Warehouse	67		No Data																	
Pilot Plant Warehouse	68		Floor	202.96	32	1100	46	NA	NA	NA	NA	281.00	52	922	46	NA	NA	NA	NA	Apr 91
Decontamination Building	69		No Data																	
General In-Process Warehouse	71		Accessible	91.43	60	180	7	NA	NA	NA	NA	132.43	50	554	7	NA	NA	NA	NA	Jul-Oct 91
			Floor	48.18	39.5	169	22	NA	NA	NA	NA	55.93	42.7	206	22	NA	NA	NA	NA	Jul-Oct 91
Drum Storage Building	72		No Data																	
Fire Brigade Training Center	73	A	No Data																	
Fire Training Pond	73	B	No Data																	
Fire Training Tank	73	C	No Data																	
Fire Training Burn Trough	73	D	No Data																	
Confined Space Burn Tank	73	E	No Data																	
Plant 2 East Pad	74	A	Accessible	NA	NA	NA	NA	4.51	0.3	25	7	NA	NA	NA	NA	45.93	4	146	6	Jun 91
			Floor	NA	NA	NA	NA	1.32	0.1	20	111	NA	NA	NA	NA	17.74	0.1	196	110	Jun 91
Plant 2 West Pad	74	B	See Plant 2 East Pad Above																	

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TABLE 4-4
Radiological Surveys of FEMP Structures and Equipment

Buildings	Building Number	Building Letter	Category	Alpha Removable (DPM) Average	Alpha Removable (DPM) Minimum Value	Alpha Removable (DPM) Maximum Value	Alpha Removable (DPM) Sample Size	Alpha Fixed (1000 DPM) Average	Alpha Fixed (1000 DPM) Minimum Value	Alpha Fixed (1000 DPM) Maximum Value	Alpha Fixed (1000 DPM) Sample Size	Beta-Gamma Removable (DPM) Average	Beta-Gamma Removable (DPM) Minimum Value	Beta-Gamma Removable (DPM) Maximum Value	Beta-Gamma Removable (DPM) Sample Size	Beta-Gamma Fixed (1000 DPM) Average	Beta-Gamma Fixed (1000 DPM) Minimum Value	Beta-Gamma Fixed (1000 DPM) Maximum Value	Beta-Gamma Fixed (1000 DPM) Sample Size	Date
Plant 8 East Pad	74 C		Floor	36.08	7	3220	200	NA	NA	NA	NA	51.07	16	4181	200	NA	NA	NA	NA	Apr 91
Plant 8 West Pad	74 D		See Plant 8 East Pad (74C) Above																	
Plant 4 Pad	74 E		Accessible	113.72	60.1	429	20	1.52	0.2	10	22	237.20	50	1500	20	19.00	1	310	32	Sep 91
			Floor	63.14	60.1	159	98	0.81	0.2	15	129	66.60	59	361	99	13.98	0.2	700	186	Sep 91
			Unaccess.	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	2.00	2	2	1	Sep 91
Plant 7 Pad	74 F		No Data																	
Plant 5 East Pad	74 G		Accessible	258.36	210	2500	200	2.11	0.2	32	249	454.80	252	6400	199	20.05	0.5	370	247	Oct 91
			Floor	229.72	52	1400	314	0.49	0.2	30	910	324.70	57	1400	314	11.83	1	450	1003	Oct 91
Plant 5 South Pad	74 H		No Data																	
Plant 6 Pads	74 J		Floor	80.25	4	1830	209	NA	NA	NA	NA	224.15	3	4276	228	59.59	1	1000	216	Nov 89
Plant 9 Pad	74 K		Floor	78.10	4	897	276	3.40	1.5	6	10	164.91	3	2260	298	154.18	1	750	298	Nov 89
Building 65 West Pad	74 L		No Data																	
Building 64 East Pad & R.R. Dock	74 M		No Data																	
Building 12 North Pad	74 N		No Data																	
Decontamination Pad	74 P		Floor	129.90	35	1380	31	NA	NA	NA	NA	263.65	35	2340	31	15.26	0.35	60	31	Sep 91
Plant 8 Old Metal Dissolver Pad	74 Q		No Data																	
Plant 8 North Pad	74 R		No Data																	
Building 63 West Pad	74 S		No Data																	
Plant 1 Storage Pad	74 T		No Data																	
Pilot Plant Pad	74 U		No Data																	
Laboratory Pad	74 V		No Data																	
Finished Products Warehouse (4A)	77		Accessible	190.50	60	762	6	NA	NA	NA	NA	453.50	59	2180	6	NA	NA	NA	NA	Sep 91
			Floor	60.00	60	60	29	NA	NA	NA	NA	59.79	59	82	29	NA	NA	NA	NA	Sep 91
D & D Building (Under Constr.)	78		No Data																	
Plant 6 Warehouse	79		Accessible	59.00	59	59	5	NA	NA	NA	NA	60.00	60	60	5	1.00	1	1	5	Sep 91
			Floor	60.59	59	105	29	NA	NA	NA	NA	69.79	60	247	29	8.00	1	65	29	Sep 91
Plant 8 Warehouse	80		No Data																	
Plant 9 Warehouse	81		Accessible	59.00	59	59	4	NA	NA	NA	NA	66.75	62	78	4	1.00	1	1	3	Sep 91
			Floor	59.00	59	59	26	NA	NA	NA	NA	62.35	60	71	26	3.31	1	10	26	Sep 91
Receiving/Incoming Material Insp	82		Accessible	19.00	19	19	28	NA	NA	NA	NA	15.54	15	19	28	NA	NA	NA	NA	Sep 91
			Floor	19.00	19	19	47	NA	NA	NA	NA	15.36	15	27	47	NA	NA	NA	NA	Sep 91
Clearwell Line	88		No Data																	
Parking Lot	89		Accessible	0.10	0.1	0.1	4	0.10	0.1	0.1	4	0.12	0.1	0.2	14	0.18	0.1	0.4	14	Jul 91
			Floor	6.68	0.1	19.2	7	0.10	0.1	0.2	21	4.59	0.1	18	83	0.17	0.1	1.8	305	Jul 91
Railroad Tracks	G-001		No Data																	
Roads	G-002		No Data																	
Storm Sewer System	G-003		No Data																	
Sumps	G-004		No Data																	
Dikes	G-005		No Data																	
Utility Lines	G-006		No Data																	
Underground Storage Tanks	G-007		No Data																	
Aboveground Storage Tanks	G-008		No Data																	
Process Trailers	G-009																			
Trailers South of Plant 7	G-009		Accessible	19.70	19.7	19.7	16	NA	NA	NA	NA	16.99	15.3	32	16	NA	NA	NA	NA	Nov 91
			Floor	19.70	19.7	19.7	14	NA	NA	NA	NA	17.89	15.3	29	14	NA	NA	NA	NA	Nov 91
Rust Construction Trailers	G-009		Accessible	18.52	13.2	19.8	31	NA	NA	NA	NA	14.58	9.9	15.7	31	1.00	1	1	31	Jul-Sep 91
			Floor	16.03	13.2	19.8	7	NA	NA	NA	NA	12.39	9.9	15.7	7	1.00	1	1	7	Jul-Sep 91
Non-process Trailers	G-010																			
6 Plex East	G-010		Accessible	20.08	18.1	28	5	0.21	0.2	0.7	56	20.48	15.2	28	5	1.15	1	9.7	56	Aug 91
			Floor	NA	NA	NA	NA	0.20	0.2	0.2	90	NA	NA	NA	NA	1.00	1	1	90	Aug 91
7 Plex North	G-010		Accessible	18.50	18.5	18.5	146	NA	NA	NA	NA	15.40	15.4	15.4	146	1.00	1	1	146	Sep 91
			Floor	18.50	18.5	18.5	7	NA	NA	NA	NA	15.40	15.4	15.4	7	1.00	1	1	7	Sep 91
			Unaccess.	18.50	18.5	18.5	7	NA	NA	NA	NA	15.40	15.4	15.4	7	1.00	1	1	7	Sep 91
10 Plex	G-010		Accessible	20.06	19.4	28	13	0.25	0.1	2.2	14	20.31	16	45	13	0.43	0.1	3.1	12	Aug 91
			Floor	19.40	19.4	19.4	14	0.13	0.1	0.3	14	16.71	16	22	14	0.18	0.1	0.8	83	Aug 91
Trailers in Grid #7	*G-010*		*Accessible*	NA	NA	NA	NA	0.20	0.2	0.2	210	NA	NA	NA	NA	0.10	0.1	0.1	209	Aug-Sep 91
			Floor	NA	NA	NA	NA	0.20	0.2	0.2	476	NA	NA	NA	NA	0.10	0.1	0.1	475	Aug-Sep 91
Pipe Bridges	G-011		No Data																	
Drums (Non-RCRA)	G-012		No Data																	
RCRA Drums	G-013		No Data																	
Inventory	G-014		No Data																	
Mobile Containers (Sea-Land)	G-015		No Data																	
East of Plant 2	P-001		No Data																	
South of Plant 8 (West)	P-002		No Data																	
South of Plant 8 (Mid)	P-003		No Data																	
South of Plant 8 (East)	P-004		No Data																	
South of Building 80	P-005		No Data																	
West of Plant 5	P-006		No Data																	
West of 7 plex (North)	P-007		No Data																	
Covered West of 7 Plex (South)	P-008		No Data																	
North of Plant 9 (Near Basin)	P-009		No Data																	
Covered between R.R. track #6 and #9	P-010		No Data																	

BLE 4-4
Radiological Surveys of FEMP Structures and Equipment

Buildings	Building Number	Building Letter	Category	Alpha Removable (DPM) Average	Alpha Removable (DPM) Minimum Value	Alpha Removable (DPM) Maximum Value	Alpha Removable (DPM) Sample Size	Alpha Fixed (1000 DPM) Average	Alpha Fixed (1000 DPM) Minimum Value	Alpha Fixed (1000 DPM) Maximum Value	Alpha Fixed (1000 DPM) Sample Size	Beta-Gamma Removable (DPM) Average	Beta-Gamma Removable (DPM) Minimum Value	Beta-Gamma Removable (DPM) Maximum Value	Beta-Gamma Removable (DPM) Sample Size	Beta-Gamma Fixed (1000 DPM) Average	Beta-Gamma Fixed (1000 DPM) Minimum Value	Beta-Gamma Fixed (1000 DPM) Maximum Value	Beta-Gamma Fixed (1000 DPM) Sample Size	Date
East of Coal Pile Run Off Basin (Constr.)	P-011		No Data																	
East of Coal Pile Run Off Basin	P-012		No Data																	
Rock Salt Pile South of Building 61	P-013		No Data																	
Sand Piles South of Building 61	P-014		No Data																	
Covered East of Building 56	P-015		No Data																	
Gravel North of Building 56	P-016		No Data																	
Copper Metal Scrap Pile	P-017		Accessible	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	34.37	0.2	100	6	Jan 91
Coal Pile	P-018		No Data																	
Third Street Dirt Pile	P-019		No Data																	
Partially Covered Along Track #11	P-020		No Data																	
Southwest Corner of Laboratory	P-021		No Data																	
North of Building 67	P-022		No Data																	
Scrap Metal Pile	P-023		No Data																	
NW Rubble Piles	P-024		No Data																	
Outside Equipment Storage Area	P-025		No Data																	
Tension Support Structure #1	TS-001		No Data																	
Tension Support Structure #2	TS-002		No Data																	
Tension Support Structure #3	TS-003		No Data																	

Data compiled as of November 15, 1991.
New data will be processed as it becomes available.

Fixed contamination values represent Background subtracted.
NA represents no available data of that type within the building.

CATEGORY
Accessible represents any accessible surface (ie. equipment, walls, desks, etc.).
Floors also represent drain grates, metal platforms, concrete, etc.
Sumps are represented by dikes and sumps.
Unaccessible is represented by overhead structures or any areas unaccessible.

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accessible and a floor sample from the sump pump house had a maximum alpha fixed of 1 x 10^6 DPM. The highest removable beta-gamma was 808,000 DPM in an accessible sample from the metal fabrication plant, and the maximum beta-gamma fixed of 8.57 x 10^6 DPM was in a floor sample from the special products plant.

Table 4-5 summarizes the results of AIP equipment surveys performed during the RI/FS investigation. The highest detections of both alpha and beta-gamma fixed were in the metals fabrication plant. The maximum alpha fixed was 161,891 DPM for a motor and shaft, and the maximum beta-gamma fixed was 984,473 DPM for ACME gridleys. The highest alpha and beta-gamma removable detections were in the preparation plant. Alpha removable of 17,000 DPM was detected in a weigh hopper, and a sample from a metal wash had a beta-gamma removable concentration of 575,511 DPM.

Radon (Rn-222) and thoron (Rn-220) monitoring results are presented in Table 4-6. Background values for radon have been reported between 0.5 pCi/ℓ and 0.95 pCi/ℓ from multiple site documents. The maximum Rn-220 concentrations were detected in the 2nd quarter of 1991 for the thorium warehouse, old plant 5 warehouse, plant 1 thorium warehouse, and the pilot plant warehouse.

TABLE 4-5
RADIOLOGICAL SURVEYS OF ABANDON-IN-PLACE (AIP) EQUIPMENT

Component And Component Designation	Equipment Location	Highest Alpha Fixed (DPM)	Highest Alpha Removable (DPM)	Highest Beta and Gamma Fixed (DPM)	Highest Beta and Gamma Removable (DPM)
Preparation Plant 1 A	1st Floor				
	Bucket Elevator	4,136	170	3,032	332
	Filter	6,692	800	22,945	1,923
	Magnetic Separator & Screw Feeder	9,081	410	17,859	842
	Overflow Tank	2,615	472	55,263	592
	Sample Box	7,092	503	45,878	947
	Sampler	914	30	5,789	89
	Water Tank	8,382	280	7,226	579
	2nd Floor				
	Tank	3,436	410	9,474	505
	Conveyor Feed Hopper	6,084	12,761	5,263	67,163
	Hopper	7,692	160	2,695	668
	Hopper	18,896	540	76,803	1,326
	Screw Feeder	15,305	1,120	13,526	2,453
	Blender	9,780	330	14,561	1,081
	Weigh Hopper	19,021	17,524	152	92,232
	3rd Floor				
	Carrier Unit	9,929	410	10,457	951
	Grizzly Feeder	8,461	180	69,226	311
	Screw Conveyor	41,945	350	44,437	468
	4th Floor				
	Dust collector	6,361	1,012	a	692
	Dust collector	5,768	839	3,194	1,783
	Metal wash	9,770	560	57,548	79,242
	Metal wash	21,429	300	42,105	575,511
Ore Refinery Plant 2 A	1st Floor				
	Condensor (Outside North)	49,545	496	174,851	431
	NAR Tower	51,141	1,347	24,255	728
	NAR Tower	1,213	43	7,549	164
	NAR Tower	692	12	2,171	22
	Pump	1,481	4	39,913	87
	Pump	1,385	16	4,111	51
	2nd Floor				
	Cooler-Mixer/Settler (Extraction)	15,594	140	45,960	220
	Pump (Harshaw Area)	1,154	16	3,429	79
NAR Towers 3 D	2nd Floor				
	C69-4-14 (NAR tower)	2,783	68	6,667	31
	C70-4-79 (Raffinate Area)	1,986	17	15,714	23
	NAR Tower	6,429	33	5,000	223
	2nd & 3rd Floors				
	NAR Tower	b	33	8,333	223
	Outside				
	NAR Tower	1,043	19	2,776	74
Harshaw System 3 F	1st Floor				
	NAR Tower	1,230	36	894	40
	NAR Tower	598	36	40,451	26
	NAR Tower	<9	78	3,600	165
	Pump	1,528	16	14,722	100
	3rd Floor				
	NAR Tower	923	19	4,549	85
	Outside				
	NAR Tower	1,077	14	246	102
	NAR Tower	1,889	24	5,524	33
	Pump	2,713	16	15,650	40
	Pump	948	8	10,928	124
	Pump Assembly	3,124	19	19,695	118
	Pump-Motor	2,833	7	3,307	26
	NAR	4,969	31	11,747	475
Combined Raffinate Tanks 3 J	1st & 2nd Floors				
	C70-5-33 (Raffinate Area)	17,386	79	76,083	104
Green Salt Plant 4 A	1st Floor				
	Scale	12,183	4,110	25,227	21,632
	Scale	26,154	1,810	28,039	9,737
	Weigh Bin	75,814	2,403	424,444	3,912
Green Salt Plant (Cont.)	Weigh Bins	30,079	1,143	100,000	1,768
	Weigh Bins	67,576	2,816	764,384	7,838
	Weigh Bin	114,315	1,553	326,596	1,625

TABLE 4-5
RADIOLOGICAL SURVEYS OF ABANDON-IN-PLACE (AIP) EQUIPMENT

Component And Component Designation	Equipment Location	Highest Alpha Fixed (DPM)	Highest Alpha Removable (DPM)	Highest Beta and Gamma Fixed (DPM)	Highest Beta and Gamma Removable (DPM)
	2nd Floor				
	Moving Bed Reactor	31,879	372	49,455	545
	Moving Bed Reactor	28,417	306	12,580	479
	Moving Bed Reactor	14,286	343	88,285	412
	Talcum Reactor	61,384	538	13,100	712
	Talcum Reactor	50,000	689	272,727	1,237
	Talcum Reactor	50,000	445	50,380	1,196
	Talcum Reactor	50,000	498	57,186	1,128
	Talcum Reactor	26,900	190	37,310	1,100
	Talcum reactor	60,880	766	13,808	819
	Talcum reactor	76,160	1,175	87,104	1,299
	Talcum reactor	39,266	148	42,424	281
	Talcum reactor	37,000	244	29,744	220
	3rd Floor				
	Scale	20,000	790	10,130	2,563
	4th Floor				
	Adams Filter	49,626	467	77,516	1,152
	Control Panel	4,465	750	275,999	1,779
	Hydrogen Burner	5,747	3,536	a	4,284
	Hydrogen Burner	56,743	3,278	a	4,093
Metals Fabrication Plant 6 A	Basement				
	100 HP Motor & Stand	1,094	69	21,151	4,374
	Duct System	223	73	417	156
	Duct System	3,840	91	4,698	141
	Electric Cages	932	104	946	4,140
	Electric Cages	1,434	55	1,259	1,920
	Gear Box	21,159	496	567,526	1,096
	Gears From Motor	6,150	961	173,506	4,340
	Generator	868	83	6,680	171
	Electric Generator/Stand	2,353	77	6,809	156
	Motor & Shaft	161,891	7,955	480,847	10,845
	Motor & Shaft	27,776	1,619	693,744	3,835
	Oil Sump	42,478	4,398	637,759	22,535
	Pressure Regulator	555	b	<bkg	b
	Pump	6,433	1,020	76,885	1,606
	Pump & Cabinet	6,362	2,222	417,360	6,382
	Pump/Motor Assembly	10,400	1,659	131,040	2,124
	Sump Pump	358	659	110,203	1,550
	Sump Pump	15,591	1,335	769,036	1,814
	Sump Tank	4,277	6,119	567,868	7,522
	Vent Blower	4,971	298	16,927	373
	1st Floor Electrical Equipment Room				
	Electric Generator & Stand	613	128	2,907	1,830
	1st Floor				
	ACME Gridleys	15,474	4,455	984,473	18,844
	Cabinet	18,214	673	42,951	1,294
	Chip Conveyor	12,153	1,288	60000+	17,328
	Rolling Mill Control Room	9,498	1,437	34,858	3,809
	Rolling Mill Cooling Bed	39,574	1,497	45,772	2,078
	Furnace & Instrument Panel	8,252	575	58,612	1,378
	Rolling Mill	7,892	450	67,197	516
	Rolling Mill Cabinet	6,288	1,269	a	2,297
	Rolling Mill Control Panel	18,054	825	91,168	4,313
	Rolling Mill Control Room	1,600	351	a	944
	Rolling Mill Control Room	7,647	159	44,011	613
	Rolling Mill Control Room	3,391	1,066	78,641	2,913
	Rolling Mill Electric Equipment Room	2,949	228	6,274	958
	Rolling Mill Generator	1,608	139	5,263	1,416
	Rolling Mill Generator	1,509	188	7,450	490
	Rolling Mill Runout Table	21,261	830	255,335	882
	Rolling Mill Shear Machine	13,662	1,483	145,549	2,381
	Rolling Mill Storage Boxes	16,695	733	121,922	17,963
	Rolling Mill Storage Boxes	14,598	678	15,756	2,310
	Rolling Mill Storage Cabinet	9,488	427	19,741	4,445
	Rolling Mill Storage Cabinet	6,322	2,631	28,034	4,680
	Rolling Mill Storage Cabinet	9,595	2,683	117,281	6,624
	Rolling Mill-1000HP	2,634	887	24,777	1,455
	Rolling Mill-100KW Generator	1,825	162	12,628	396
als Fabrication Plant (cont.)	Rolling Mill-Adjacent to Quench Tank	20,408	7,527	403,556	65,262
	Rolling Mill-DC Generator & Stand	932	b	1,810	b
	Rolling Mill-DC Generator & Stand	2,010	389	5,322	965
	Rolling Mill-DC Generator & Stand	1,227	475	14,035	3,718
	Rolling Mill-DC Generators	1,010	112	2,886	4,413
	Rolling Mill-Electrical Alley	744	139	110	630

TABLE 4-5
RADIOLOGICAL SURVEYS OF ABANDON-IN-PLACE (AIP) EQUIPMENT

Component And Component Designation	Equipment Location	Highest Alpha Fixed (DPM)	Highest Alpha Removable (DPM)	Highest Beta and Gamma Fixed (DPM)	Highest Beta and Gamma Removable (DPM)
	Rolling Mill-Generator Rack	628	135	1,246	461
	Rolling Mill-Motor & Generator	2,431	206	578,569	639
	Rolling Mill-Motor & Sump	1,651	67	11,738	201
	Rolling Mill-Motors & Generators	1,458	73	8,772	274
	Scale	1,484	767	44,856	1,498
	Transfer Conveyor	13,143	981	723,358	1,738
	Vacuum Cleaner	5,459	1,212	39,607	3,486
Plant 7 7 A	6th Floor				
	Dissociator Unit	7,145	803	72,678	1,124
Pilot Plant Annex 37	1st Floor				
	Briquette maker	61,488	280	131,621	23,147

a - Field personnel were unable to obtain a reading.
b - Reading not available.

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TABLE 4-6
RADON (Rn222) AND THORON (Rn220) MONITORING BY LOCATION AND PERIOD

Component	Component Designation	From	To	pCi/L	Contaminant Sampled	Average Rn222+Rn220	Average Rn222 Only	Average Rn220 Only	Maximum Rn220	Minimum Rn220
3RD QUARTER 1990										
Thorium Warehouse	64	07/11/90	10/12/90	68.7	Rn222+Rn220	63.9	1.4	62.5	67.3	57.7
				59.1	Rn222+Rn220					
				2.0	Rn222					
				0.8	Rn222					
(Old) Plant 5 Warehouse	65	07/11/90	10/12/90	85.0	Rn222+Rn220	76.25	94.5	a	a	a
				67.5	Rn222+Rn220					
				103.3	Rn222					
				85.7	Rn222					
Plant 1 Thorium Warehouse	67	07/11/90	10/12/90	33.0	Rn222+Rn220	33.15	5.55	27.6	27.8	27.5
				33.3	Rn222+Rn220					
				4.2	Rn222					
				6.9	Rn222					
Pilot Plant Warehouse	68	07/11/90	10/12/90	22.1	Rn222+Rn220	20.45	14.55	5.9	7.6	4.3
				18.8	Rn222+Rn220					
				15.7	Rn222					
				13.4	Rn222					
4TH QUARTER 1990										
Thorium Warehouse	64	10/12/90	01/09/91	30.1	Rn222+Rn220	29.15	1.6	27.6	28.5	27.2
				28.2	Rn222+Rn220					
				1.4	Rn222					
				1.8	Rn222					
(Old) Plant 5 Warehouse	65	10/12/90	01/09/91	78.6	Rn222+Rn220	77.85	59.45	18.4	19.2	17.7
				77.1	Rn222+Rn220					
				75.1	Rn222					
				43.8	Rn222					
Plant 1 Thorium Warehouse	67	10/12/90	01/09/91	19.9	Rn222+Rn220	23.55	5.6	18	21.6	14.3
				27.2	Rn222+Rn220					
				6.9	Rn222					
				4.3	Rn222					
Pilot Plant Warehouse	68	10/12/90	01/09/91	10.9	Rn222+Rn220	10.2	7.7	2.5	3.2	1.8
				9.5	Rn222+Rn220					
				6.8	Rn222					
				8.6	Rn222					
1ST QUARTER 1991										
Thorium Warehouse	64	01/09/91	04/10/91	43.0	Rn222+Rn220	42.6	1.1	41.5	41.9	41.1
				42.2	Rn222+Rn220					
				1.2	Rn222					
				1.0	Rn222					
(Old) Plant 5 Warehouse	65	01/09/91	04/10/91	89.0	Rn222+Rn220	80.1	71.25	8.85	17.8	a
				71.2	Rn222+Rn220					
				80.0	Rn222					
				62.5	Rn222					
Plant 1 Thorium Warehouse	67	01/09/91	04/10/91	17.7	Rn222+Rn220	19.05	1.95	17.1	18.5	15.8
				20.4	Rn222+Rn220					
				1.9	Rn222					
				2.0	Rn222					
Pilot Plant Warehouse	68	01/09/91	04/10/91	32.0	Rn222+Rn220	31.35	5.1	26.25	26.9	25.6
				30.7	Rn222+Rn220					
				5.6	Rn222					
				4.6	Rn222					
2ND QUARTER 1991										
Thorium Warehouse	64	04/10/91	07/03/91	136.6	Rn222+Rn220	158.6	1.6	157	179	135
				180.6	Rn222+Rn220					
				0.9	Rn222					
				2.3	Rn222					
(Old) Plant 5 Warehouse	65	04/10/91	07/03/91	178.0	Rn222+Rn220	197	87.5	109.6	128.5	90.5
				216.0	Rn222+Rn220					
			72938	82.2	Rn222					
				92.7	Rn222					
Plant 1 Thorium Warehouse	67	04/10/91	07/03/91	68.6	Rn222+Rn220	73.6	7.5	66.1	71.1	61.1
				78.6	Rn222+Rn220					
				6.7	Rn222					
				8.3	Rn222					
Pilot Plant Warehouse	68	04/10/91	07/03/91	36.0	Rn222+Rn220	68.4	26.3	42.1	74.5	9.8
				100.7	Rn222+Rn220					
				20.5	Rn222					
				32.0	Rn222					
Recovery Plant	8 A	04/10/91	07/03/91	36.3	Rn222+Rn220	34.3	1.3	33	35	30.9
				32.2	Rn222+Rn220					
				1.3	Rn222					
				1.2	Rn222					

NOTE: All samples collected by Terradex Cups, a passive monitor.
Background value for Radon-222 has been reported between 0.5 pCi to 0.95 pCi from multiple site documents. This value is location dependent.
For worker health over a facility site, an annual average concentration cannot exceed 30 pCi/L above background for Radon-222.
For public health outside of a facility site, an annual average concentration cannot exceed 3 pCi/L above background for Radon-222. Values cannot exceed 100 pCi/L above background at any given point for Radon-222.

a - Values are not applicable due to anomalies in the measurement of Radon-220.

Average Rn220 is calculated by subtracting the Average Rn222 Only value from the Average Rn222+Rn220 value.
Maximum and Minimum Rn220 are calculated by subtracting the Average Rn220 value from the Average Rn222+Rn220 values.

4.1.2 Air Quality

4.1.2 Air Quality

Air quality and meteorology at the FEMP have been extensively investigated in the past. Brief descriptions of reports from these investigations are presented in Section 3.1.2. Uranium and radon are the principal present-day airborne contaminants of concern. Both are extensively monitored by the FEMP. In this section, analytical results of the monitoring are summarized in tabular form. Data presented in the tabulations are the results of recent FEMP monitoring activities, for these are the only available data that reasonably represent present-day conditions, and typify the nature and extent of contamination under the no-action alternative.

1988 was the last full year of production at the FEMP. Emissions of radionuclides during 1989 and 1990 were substantially reduced, as shown in Table 4-7. The methods used to calculate emissions are detailed in the source documents (WMCO 1988, 1989, 1990). Corresponding reductions in concentrations of airborne uranium occurred at the 16 monitoring sites in and around the FEMP (Table 4-8). Monitored concentrations of airborne radon did not change substantially during 1989 and 1990 (Table 4-9), but were notably lower after the placement of bentonite in the K-65 silos during 1991 (as discussed in Section 4.2).

Average concentrations of airborne radionuclides during 1990 are presented in Table 4-10. At the 95% confidence interval, the concentration of each radionuclide at each of the 16 air monitoring sites is seen to be well within the Derived Concentration Guide (DCG), which is a DOE guideline for dose to a member of the general public. The DCG referred to is the concentration of a radionuclide in air that, under conditions of continuous exposure for one year by one exposure mode (i.e., inhalation), would result in an effective dose equivalent of 100 millirem. 100 millirem is the DOE public dose limit, an annual aggregate including all DOE sources of radiation and all exposure modes. It is the sum of the effective dose equivalent from exposures of radiation external to the body (e.g., direct gamma radiation) during the year, plus the committed effective dose equivalent from radionuclides taken into the body (e.g., by inhalation and ingestion) during the year.

The effective dose equivalent from all airborne radionuclides during 1990 (excluding radon) has been shown to be less than 10 millirem (WMCO 1991), demonstrating compliance with 40CFR61, Subpart H: "National Emission Standards for Emissions of Radionuclides Other Than Radon From Department of Energy Facilities."

Overall, air quality in the vicinity of the FEMP is generally regarded as "good", with respect to National Ambient Air Quality Standards (NAAQS). These nationally-adopted health-protective standards apply to six pollutants regulated under the Clean Air Act: inhalable (PM10) particulates, carbon monoxide, sulfur dioxide, nitrogen dioxide, ozone, and lead. Historically, none of these has been monitored in the immediate vicinity of the FEMP, because there are few sources in the vicinity. Extensive monitoring has been performed by the Southwestern Ohio Air Pollution Control Agency

TABLE 4-7

ESTIMATED AIRBORNE EMISSIONS, 1988-1990[a]

Radionuclide	Total microCuries[b]		
	1988	1989	1990
U-234	37900	4950	819
U-235	2080	572	35.4
U-236	530	426	24.1
U-238	35400	9890	1080
Sr-90	159	14.8	3.42
Tc-99	5170	870	105
Ru-106	210	70.1	12.3
Cs-137	1210	49.2	10.4
Ba-137m	1210	49.2	10.4
Ra-226	145	193	15.6
Ra-228	26	29.3	3.41
Th-228	229	86.7	18.5
Th-230	2910	3620	320
Th-232	159	32.7	4.41
Th-234	165000	16200	2850
Pa-234m	72700	16200	2850
Np-237	31	5.89	0.542
Pu-238	9.69	2.4	0.303
Pu-239	30.7	14.3	1.65
Pu-240	16.3	5.52	0.553
Pu-241	92.1	61.7	6.52
Pu-242	Not Available	0.0026	0.000152

[a] Sources: WMCO (1988, 1989, 1990)
[b] 1 Curie = 10^6 microCuries

TABLE 4-8

URANIUM CONCENTRATIONS IN AIR, 1988-1990[a]

Sample Location[b]	attoCuries per cubic meter (aCi/m^3)[c]		
	1988 Average	1989 Average	1990 Average
Fenceline			
AMS 1	2600	310	150
AMS 2	2570	380	140
AMS 3	3590	710	240
AMS 4	770	200	87
AMS 5	830	220	91
AMS 6	900	310	120
AMS 7	500	170	89
Onsite			
AMS 8	4320	720	360
AMS 9	6780	1840	1300
Offsite			
AMS 10	250	130	57
AMS 11	290	70	40
AMS 12	140	60	42
AMS 13	630	90	58
AMS 14	180	70	44
AMS 15	..[d]	80	51
AMS 16	..[d]	120	57

[a] Sources: WMCO (1988, 1989, 1990)
[b] Locations are shown in Figures 3-4 and 3-5.
[c] 1 Curie = 10^{18} attoCuries.
[d] Did not operate during 1988.

TABLE 4-9

RADON IN AMBIENT AIR, 1988-1990[a]

Fenceline Location[b]	1990 pCi/l[c]	1989 pCi/l[c]	1988 pCi/l[c]	Background Locations[b]	1990 pCi/l[c]	1989 pCi/l[c]	1988 pCi/l[c]	Other Locations[b]	1990 pCi/l[c]	1989 pCi/l[c]	1988 pCi/l[c]
AMS 1	0.4	0.6	0.7	BKGD 1	0.4	0.4	0.3	AMS 8	0.5	0.6	0.8
AMS 2	0.6	0.7	1.0	BKGD 2	0.4	0.6	0.9	AMS 9	0.6	0.8	0.8
AMS 4	0.4	0.7	0.7	AMS 15	0.6	---[d]	---[d]	AMS 10	0.5	0.9	0.8
AMS 6	0.6	0.9	1.0	AMS 16	0.6	---[d]	---[d]	AMS 11	0.6	0.6	0.9
AMS 7	0.5	0.6	1.5					AMS 12	0.7	0.6	0.7
FMPC-A	1.1	0.8	1.3					AMS 13	0.7	0.7	0.5
FMPC-B	0.7	0.8	1.7					RES 1	0.7	0.8	1.3
FMPC-C	0.5	0.7	1.4					RES 2	0.6	0.9	0.9
FMPC-D	0.5	0.5	1.1					RES 3	0.6	0.8	1.0
FMPC-E	0.7	0.7	1.2								
FMPC-F	0.5	0.7	1.1								
FMPC-G	0.8	0.8	0.9								
FMPC-H	1.5	0.6	1.0								
FMPC-I	1.1	0.7	1.7								
FMPC-J	1.2	0.5	0.9								
FMPC-K	0.7	1.0	2.1								
FMPC-L	0.6	0.8	1.3								
FMPC-M	0.7	0.8	2.0								
FMPC-N	0.8	0.8	0.8								
FMPC-O	0.7	0.8	1.3								
FMPC-P	0.9	1.0	0.9								

Summary - 1988 - 1990 Results

	Fenceline				- Background				= Net Fencelin[e]		
	1990	1989	1988		1990	1989	1988		1990	1989	1988
Average	0.75	0.74	1.2	Average	0.52	0.50	0.62	Average	0.23	0.24	0.60
Std. Dev.	±0.27	±0.14	±0.4	Std. Dev.	±0.09	±0.07	±0.43	Std. Dev.	±0.28	±0.15	±0.60

[a]Sources: WMCO (1988, 1989, 1990)
[b]See Figure 3-5 for locations.
[c]1 Curie = 10^{12} picoCuries
[d]1990 was the first year samples were collected at these locations.
[e]DOE guideline concentration is 3.0 pCi/l above-background, as stated in DOE Draft Order 5400.5, February, 1990.

TABLE 4-10

RADIONUCLIDES IN AIR, 1990[a]
CONCENTRATIONS OF AIRBORNE RADIONUCLIDES AT AIR MONITORING STATIONS[b,c]
IN ATTOCURIES PER CUBIC METER (a/Ci/m^3)[d]

Radionuclide	Derived Concentration Guides[e] aCi/m^3	AMS 1	AMS 2	AMS 3	AMS 4	AMS 5	AMS 6	AMS 7	AMS 8	AMS 9
Sr-90	9,000,000	1.6±0.5	1.3±0.4	2.4±0.5	1.9±0.5	<0.71	3.8±0.7	2.9±0.5	10±1.2	4.1±0.6
Tc-99	2,000,000,000	<89	<100	<74	<77	95±61	<110	<100	<110	<95
Ru-106[f]	30,000,000	<290	<525	<230	<410	<290	<370	<490	<480	<580
Cs-137	400,000,000	<34	<42	<34	<59	<39	<29	<40	<39	<59
Ra-226	1,000,000	<1.1	<1.6	<1.2	<0.8	<1.2	<1.6	<1.0	1.7±1.2	<1.6
Ra-228	3,000,000	<10	<12	<8.8	<8.0	<11	<8.9	<1.2	<14	<9.8
Th-228	40,000	<3.7	<2.6	3.0±1.9	<3.5	<4.2	<5.8	3.5±3.2	<8.9	<3.6
Th-230	7,000	<3.7	<2.6	3.0±1.9	<3.5	<4.2	6.9±4.5	6.7±3.9	11±7	<3.6
Th-232	20,000	<3.7	<2.6	<2.4	<3.5	<4.2	<5.8	<4.7	<8.9	<3.6
Np-237	30,000	<0.5	<0.9	<1.0	<1.0	<1.4	<0.7	<0.5	<0.4	<0.9
Pu-238	30,000	<1.0	<1.1	<1.0	<1.2	<1.1	<1.0	<1.0	<1.0	<1.0
Pu-239/240	20,000	<0.8	<1.1	<1.0	<0.09	<0.9	<1.0	<1.0	<1.0	<1.0
U-234	90,000	68±36	27±14	130±68	39±21	33±17	33±17	39±20	390±210	340±180
U-235	100,000	3.2±0.4	3.0±0.4	4.8±0.7	1.8±0.2	1.8±0.3	2.6±0.4	1.8±0.3	7.4±0.1	24±3.3
U-236	100,000	1.7±0.8	1.0±0.5	2.2±1.0	0.7±0.3	0.4±0.2	0.8±0.4	0.6±0.3	6.8±3.2	11±5
U-238	100,000	73±9.3	71±9.0	120±15	42±5.4	44±5.6	59±7.5	41±5.2	180±22	610±77

See footnotes at end of table

TABLE 4-10
(Continued)

Radionuclide	Derived Concentration Guides[e] aCi/m^3	AMS 10	AMS 11	AMS 12	AMS 13	AMS 14	AMS 15	AMS 16
Sr-90	9,000,000	<9.5	7.8±1.8	10.7±1.9	8.0±1.6	<12.6	8.6±2.0	10.5±2.1
Tc-99	2,000,000,000	<140	<150	<190	<130	<150	<160	<140
Ru-106[f]	30,000,000	<1500	<1400	<1400	<1400	<1400	<1500	<1400
Cs-137	400,000,000	<11	<15	<17	<13	<14	<14	<18
Ra-226	1,000,000	21±3.9	5.1±1.9	3.5±1.0	5.4±1.9	8.7±2.2	4.7±1.4	1.9±1.2
Ra-228	3,000,000	<7.9	<16	<27	<23	<10	<25	<13
Th-228	40,000	4.9±3.3	37±7.5	36±7.4	26±5.9	35±6.9	13±4.8	30±7.1
Th-230	7,000	4.9±3.3	<2.6	3.3±2.0	<2.6	3.9±2.0	10.4±4.3	5.9±3.0
Th-232	20,000	<4.1	<2.6	<2.5	<2.6	<2.3	<4.0	<3.3
Np-237	30,000	<0.3	<0.8	<0.8	<0.7	<0.9	<1.7	0.6±0.6
Pu-238	30,000	<0.8	<0.9	<0.9	<0.7	<0.8	<0.9	<0.7
Pu-239/240	20,000	<0.8	<0.7	<0.7	<0.7	<0.8	1.6±1.0	<0.7
U-234	90,000	118±15.7	59±9.1	51±7.4	45±6.9	120±19	59±8.7	37±6.1
U-235	100,000	7.7±2.7	4.4±2.1	2.2±1.3	3.3±1.6	8.5±4.0	3.7±1.8	2.1±1.4
U-236	100,000	117±16	54±8.5	47±6.9	47±7.2	114±18	59±8.7	40±6.5
U-238	100,000							

[a]Sources: WMCO (1988, 1989, 1990)
[b]A composite of 50 weekly samples at AMS 10, 11, and 13; 51 weekly samples at AMS 14 and AMS 15; 52 weekly samples at all other air monitoring stations. Locations of stations are shown in Figure 3-4.
[c]The plus/minus values are the uncertainty in the analytical results of the 95% confidence level.
[d]1 Curie = 10^{18} attoCuries.

(SWOAPCA) in urban locations where the highest concentrations within its four-county jurisdiction are found. With the exception of ozone, pollutant concentrations in these locations meet the NAAQS. Ozone is a widespread problem that will require regional control and abatement measures, such as the long-range measures mandated by the Clean Air Act Amendments of 1990.

Air quality standards for toxic compounds not regulated under the Clean Air Act are defined by individual states. The State of Ohio, acting through the SWOAPCA, has established standards for chemically toxic compounds including ammonia, hydrogen fluoride, and nitric acid, all of which have been released from the FEMP in relatively small amounts. Estimates of the air quality impact of the amounts released have been made by dispersion modeling and indicate that concentrations in recent years are well within the limits set by the State of Ohio.

4.1.3 Surface Water/
Sediments

4.1.3 Surface Water and Sediments

This section describes the results of surface water and sediment sampling at the FEMP and vicinity. Results are summarized for the Great Miami River, Paddys Run, and the various surface drainages on-property.

4.1.3.1 Great Miami River

NLO (1977 - 1985) and WMCO (1986 - 1991), Environmental Monitoring Annual Reports

These surface water and sediment sampling programs record the effects of routine discharges of treated effluent into the Great Miami River. There are three surface water sampling locations on the river: Station W1, located near the Ross Bridge, is upstream from the discharge from the main effluent line (Figure 3-10). Samples from Station W1 are used to establish background conditions. Station W3 is located near the New Baltimore Bridge, downstream from the discharge but upstream from the confluence with Paddys Run. Station W4 is located at Miamitown, downriver from the confluence with Paddys Run. In addition, sediment samples were collected several miles upstream from the Ross Bridge, at the Bolton Water Works; immediately above and below the effluent discharge, near the "Big Bend," and immediately upstream and downstream from the confluence with Paddys Run (Figure 3-10).

Surface Water

Uranium isotopes, radium isotopes, cesium-137, gross alpha, fluoride, chloride, and pH are essentially indistinguishable upstream and downstream from the effluent discharge (Tables 4-11, 4-12). Other parameters show slight departures from this trend. Technetium-99 was lower at the downstream stations, and total uranium, strontium-90, gross beta, and nitrate were slightly higher on average downstream from the effluent discharge. Average fluoride levels in the Great Miami River were generally higher than in Paddys Run, although fluoride levels in 1987 and 1988 were lower (0.61 mg/ℓ or less) (Table 4-12).

Sediments

Data collected from 1976 to 1984 indicate that uranium in sediment generally increased immediately downstream from the effluent discharge, then decreased to levels comparable to upstream stations (Table 4-13). The highest uranium concentrations were observed in 1983, 3.10 pCi/g 50 feet downstream of the discharge and 1.80 pCi/g and 1.70 pCi/g at two upstream locations. Data collected from 1988 to 1990 do not show this pattern (Table 4-14). The highest technetium-99 concentrations were found downstream from the discharge. Radium, thorium, and plutonium isotopes concentrations were similar above and below the discharge (Table 4-14).

TABLE 4-11

RADIONUCLIDES IN SURFACE WATER OF THE GREAT MIAMI RIVER ENVIRONMENTAL MONITORING ANNUAL REPORTS, 1976-1990

	Sample Location		
Radionuclide	W1	W3	W4
Gross Alpha			
Years	1976-1988	1976-1988	1976-1988
Concentration Range (pCi/ℓ)	0.4-31	0.4-14	<0.9-29
Number of Samples	674	676	673
Average Concentration[a] (pCi/ℓ)	2	2	2
Gross Beta			
Years	1976-1988	1976-1988	1976-1988
Concentration Range (pCi/ℓ)	0.4-100	0.4-63	0.4-386
Number of Samples	674	675	673
Average Concentration (pCi/ℓ)	9	11	12
Cesium-137			
Years	1984-1990	1984-1990	1984-1990
Concentration Range (pCi/ℓ)	<1.89-<10.0	<1.62-<11	<1.62-<11
Number of Samples	13	13	13
Average Concentration (pCi/ℓ)	2.0	2.0	2.0
Radium-226			
Years	1976-1990	1976-1990	1976-1990
Concentration Range (pCi/ℓ)	<0.001-0.90	<0.001-0.90	<0.001-0.90
Number of Samples	220	220	218
Average Concentration (pCi/ℓ)	0.21	0.21	0.24
Radium-228			
Years	1976-1990	1976-1990	1976-1990
Concentration Range (pCi/ℓ)	<0.001-5.0	<0.001-2.3	<0.001-<2.0
Number of Samples	220	220	218
Average Concentration (pCi/ℓ)	0.3	0.3	0.3

TABLE 4-11
(Continued)

Radionuclide	Sample Location W1	W3	W4
Strontium-90			
Years	1984-1990	1984-1990	1984-1990
Concentration Range (pCi/ℓ)	0.15-<1.4	0.14-1.9	0.08-2.4
Number of Samples	13	13	13
Average Concentration (pCi/ℓ)	0.4	1.1	1.2
Technetium-99			
Years	1984-1990	1984-1990	1984-1990
Concentration Range (pCi/ℓ)	1.08-1351.35	2.70-20.9	4.32-<18
Number of Samples	13	13	13
Average Concentration (pCi/ℓ)	678	10.2	9
Uranium-234			
Years	1984-1988	1984-1988	1984-1988
Concentration Range (pCi/ℓ)	0.78-4.04	0.81-4.58	0.81-4.00
Number of Samples	9	9	9
Average Concentration (pCi/ℓ)	1.89	1.51	1.53
Uranium-235			
Years	1984-1986	1984-1986	1984-1986
Concentration Range (pCi/ℓ)	0.03-0.30	0.03-<0.27	0.03-0.27
Number of Samples	5	5	5
Average Concentration (pCi/ℓ)	0.2	0.12	0.12
Uranium-236			
Years	1984-1986	1984-1986	1984-1986
Concentration Range (pCi/ℓ)	0.005-0.30	0.008-<0.27	0.011-<0.27
Number of Samples	5	5	5
Average Concentration (pCi/ℓ)	0.16	0.08	0.08

TABLE 4-11
(Continued)

Radionuclide	Sample Location		
	W1	W3	W4
Uranium-235/236			
Years	1987-1988	1987-1988	1987-1988
Concentration Range (pCi/ℓ)	<0.02-0.2	<0.02-<0.2	<0.02-<0.2
Number of Samples	4	4	4
Average Concentration (pCi/ℓ)	0.1	0.06	0.06
Uranium-238			
Years	1984-1988	1984-1988	1984-1988
Concentration Range (pCi/ℓ)	0.73-4.02	0.81-4.65	0.81-4.00
Number of Samples	9	9	9
Average Concentration (pCi/ℓ)	2.03	1.98	1.83
Uranium-total			
Years	1976-1990	1976-1990	1976-1990
Concentration Range (pCi/ℓ)	0.3-25.73	0.3-16.25	0.3-18.97
Number of Samples	776	776	757
Average Concentration (pCi/ℓ)	1.3	1.4	1.6

[a] Average concentration represents the mean of the annual average concentration for the years indicated.

TABLE 4-12

ION CONCENTRATIONS AND pH IN SURFACE WATER OF THE GREAT MIAMI RIVER ENVIRONMENTAL MONITORING ANNUAL REORTS, 1976-1990

Parameter	Sample Location		
	W1	W3	W4
Fluoride			
Years	1976-1990	1976-1990	1976-1990
Concentration Range (mgℓ)	0.1-2.1	0.2-2.3	0.2-1.7
Number of Samples	777	777	760
Average Concentration[a] (mgℓ)	0.5	0.5	0.5
Nitrate			
Years	1976-1990	1976-1990	1976-1990
Concentration Range (mgℓ)	0.5-39	0.20-158	0.10-105.0
Number of Samples	771	774	755
Average Concentration (mgℓ)	5	6	5.8
Chloride			
Years	1979-1990	1979-1990	1979-1990
Concentration Range (mgℓ)	12.0-159	11.0-155	11.0-156
Number of Samples	587	587	574
Average Concentration (mgℓ)	56	56	56
pH			
Years	1979-1990	1979-1990	1979-1990
Range	7.5-9.2	7.3-9.3	7.3-9.6
Number of Samples	625	623	609
Average	8.6	8.3	8.4

[a]Average concentration represents the mean value of the annual average concentrations for the dates indicated.

TABLE 4-13

URANIUM AND TECHNETIUM-99 CONCENTRATIONS IN GREAT MIAMI RIVER SEDIMENT ENVIRONMENTAL MONITORING ANNUAL REPORTS, 1976-1984

Sampling Location	Years	Average Uranium Concentration (pCi/g)
Upstream of FEMP Effluent Discharge		
3.7 Miles	1976-1984	1.09
1.5 Miles	1976-1984	0.79
Downstream from FEMP Effluent Discharge		
50 Feet	1976-1984	1.59
0.8 Mile	1976-1984	0.68
3.3 Miles	1976-1984	0.83
4.5 MIles	1976-1984	1.11
4.7 Miles	1976-1984	1.18

Sampling Location	Years	Average Technetium-99 Concentration (pCi/g)
Upstream of FEMP Effluent Discharge		
3.7 Miles	1983-1984	NA[a]
1.5 Miles	1983-1984	0.04
Downstream from FEMP Effluent Discharge		
	1983-1984	2.75
50 Feet	1983-1984	NA
0.8 Mile	1983-1984	0.85
3.3 Miles	1983-1984	NA
4.5 Miles	1983-1984	0.55
4.7 Miles		

[a]NA, Data not available

TABLE 4-14

RADIONUCLIDES IN SEDIMENTS OF THE GREAT MIAMI RIVER ENVIRONMENTAL MONITORING ANNUAL REPORTS, 1985-1990

Radionuclide	Sample Location: From Above FEMP Effluent Line	From Below FEMP Effluent Line, Above Paddys Run	From Below Paddys Run	From Above FEMP Effluent To Below Paddys Run[a]
Uranium-234				
Years	1988-1990	1988-1990	1988-1990	1986-1987
Concentration Range (pCi/g)	0.4-1.2	0.60-1.5	0.38-<1.0	0.16-0.75
Number of Samples[b]	6	7	4	NA[c]
Average Concentration[d] (pCi/g)	0.7	0.7	0.59	0.40
Uranium-235/236				
Years	1988-1990	1988-1990	1988-1990	1986-1987
Concentration Range (pCi/g)	<0.01-<1.0	<0.05-<1.0	<0.05-<1.0	0.0027-<0.1
Number of Samples	6	7	4	NA
Average Concentration (pCi/G)	0.2	0.2	0.19	0.02
Uranium-238				
Years	1988-1990	1988-1990	1988-1990	1986-1987
Concentration Range (pCi/g)	0.52-1.0	0.58-1.6	0.37-<1.0	0.16-<0.84
Number of Samples	6	7	4	NA
Average Concentration (pCi/g)	0.7	0.7	0.59	0.27
Uranium-total				
Years	1985	1985	1985	1985-1990
Concentration Range (pCi/g)	0.8-1.5	0.6-2.6	0.7	NA
Number of Samples	4	4	1	0
Average Concentration (pCi/g)	1.1	1.6	0.7	NA

3577

TABLE 4-14
(Continued)

Radionuclide	Sample Location: From Above FEMP Effluent Line	From Below FEMP Effluent Line, Above Paddys Run	From Below Paddys Run	From Above FEMP Effluent To Below Paddys Run[a]
Radium-223				
Years	1985-1990	1985-1990	1985-1990	1986
Concentration Range (pCi/g)	NA	NA	NA	0.16-0.31
Number of Samples	0	0	0	NA
Average Concentration (pCi/g)	NA	NA	NA	0.22
Radium-224				
Years	1988-1989	1988-1989	1988-1990	1986-1987
Concentration Range (pCi/g)	0.37-0.81	0.34-1.1	0.24-0.75	<0.0739-<0.892
Number of Samples	3	3	2	NA
Average Concentration (pCi/g)	0.62	0.54	0.50	0.37
Radium-226				
Years	1988-1990	1988-1990	1988-1990	1986-1987
Concentration Range (pCi/g)	0.52-0.81	0.40-1.0	0.42-0.93	0.116-1.1
Number of Samples	6	7	4	NA
Average Concentration (pCi/g)	0.68	0.65	0.65	0.72
Radium-228				
Years	1988-1990	1988-1990	1988-1990	1986-1987
Concentration Range (pCi/g)	0.39-0.73	0.28-0.82	0.21-0.77	<0.147-0.78
Number of Samples	6	7	4	NA
Average Concentration (pCi/g)	0.47	0.49	0.50	0.37

TABLE 4-14
(Continued)

Radionuclide	Sample Location: From Above FEMP Effluent Line	From Below FEMP Effluent Line, Above Paddys Run	From Below Paddys Run	From Above FEMP Effluent To Below Paddys Run[a]
Thorium-228				
Years	1988-1990	1988-1990	1988-1990	1986-1987
Concentration Range (pCi/g)	0.14-1.5	0.12-1.4	0.12-1.3	0.33-1.07
Number of Samples	6	7	4	NA
Average Concentration (pCi/g)	0.76	0.66	0.61	0.61
Thorium-230				
Years	1988-1990	1988-1990	1988-1990	1986-1987
Concentration Range (pCi/g)	0.36-1.7	0.32-1.3	0.33-1.1	0.15-1.16
Number of Samples	6	7	4	NA
Average Concentration (pCi/g)	0.75	0.65	0.65	0.74
Thorium-232				
Years	1988-1990	1988-1990	1988-1990	1986-1987
Concentration Range (pCi/g)	0.13-1.1	0.10-<1.0	0.11-<1.0	0.09-1.08
Number of Samples	6	7	4	NA
Average Concentration (pCi/g)	0.45	0.41	0.42	0.47
Plutonium-238				
Years	1988-1990	1988-1990	1988-1990	1986-1987
Concentration Range (pCi/g)	<0.01-<0.11	<0.01-<0.076	<0.01-0.033	0.0047-<0.05
Number of Samples	6	7	4	NA
Average Concentration (pCi/g)	0.013	0.01	0.01	0.01

TABLE 4-14
(Continued)

Radionuclide	Sample Location: From Above FEMP Effluent Line	From Below FEMP Effluent Line, Above Paddys Run	From Below Paddys Run	From Above FEMP Effluent To Below Paddys Run[a]
Plutonium-239/240				
Years	1988-1990	1988-1990	1988-1990	1986-1987
Concentration Range (pCi/g)	<0.01-0.043	<0.01-<0.10	<0.01-0.085	0.0018-0.04
Number of Samples	6	7	4	NA
Average Concentration (pCi/g)	0.01	0.01	0.01	0.02
Technetium-99				
Years	1985-1990	1985-1990	1988-1990	1986-1987
Concentration Range (pCi/g)	0.0-0.95	0.0-4.9	<0.69-<0.90	<1.1-<1.4
Number of Samples	7	10	4	NA
Average Concentration (pCi/g)	0.31	0.84	0.42	1.60

[a]The annual monitoring data for 1986 and 1987 were presented as an average value for the entire section of the river.
[b]Number of samples is approximate; the number of samples from the 1988 sampling events is not available and is not included in this number.
[c]NA, Data not available or may not exist.
[d]Average concentration represents the mean of the annual average concentrations for the dates indicated.

NLO (1985a), "History of FMPC Radionuclide Discharges"

Surface Water

Tables 4-15 and 4-16 present the amounts of uranium discharged to the Great Miami River during the operation of the FEMP through 1984, as reported in this study. Although records were maintained concerning the discharge of uranium in wastewater, other radionuclides present in minor concentrations were not as closely monitored. Beginning in 1969, estimates were made for the other radionuclides, based on several long-term composite samples each year.

IT (1986), "Interim Report - Air, Soil, Water, and Health Risk Assessment in the Vicinity of the FMPC, Fernald, Ohio."

Surface Water

Surface water samples for uranium analysis were collected in 1985 at the Ross Bridge (Figure 3-6). The average of 50 surface water samples 10 µg/ℓ (6.8 pCi/ℓ) was considered to indicate background. All downstream samples were lower than this (Table 4-17). Total thorium and uranium concentrations displayed similar trends, with either the most upstream sample or the sample downstream of the effluent line usually having the highest concentration. Concentrations of both radionuclides typically declined to background at sample location R-3.

The surface water samples were analyzed for a variety of metals, organic compounds, and other general chemical parameters. These analyses show no differences between downstream and upstream samples. Most analyzed compounds were not detected, were not present in sufficient concentrations to constitute a detection, or were also present in the sample blank.

Sediment

Background uranium concentrations were calculated from the upstream samples previously collected from the Ross Bridge at RM 25.6 (2.55 µg/g or 1.78 pCi/g) and near the SOWC wells at RM 27.8 (2.48 µg/g or 1.66 pCi/g) from 1974 through 1983. Four sediment samples collected coincident with the water samples did not have levels above these estimated background levels (Table 4-18). Total thorium concentrations were higher total uranium, but the concentrations followed a similar trend, generally decreasing downstream.

Sediment samples were also analyzed for a variety of metals, organic compounds, and other general chemical parameters. These analyses show no differences between downstream and upstream samples. Most analyzed compounds were not detected, were not present in sufficient concentrations to constitute a detection, or were also present in the sample blank. One of the more notable detections was the presence of trace concentrations (typically less than 0.5 mg/kg) of PCB compounds in all of the sediment samples from the Great Miami River. The PCB was also detected in sediment collected upstream from the FEMP and is probably associated with a PCB spill which occurred in Dayton, OH

TABLE 4-15

FISCAL YEAR RECORD OF URANIUM IN WASTEWATER DISCHARGED TO THE GREAT MIAMI RIVER

Fiscal Year[a]	Total Uranium in Wastewater Discharge (kg)
1984	1054
1983	564
1982	755
1981	576
1980	685
1979	1175
1978	880
1977	965
1976A	179
1976	875
1975	1852
1974	1066
1973	1126
1972	1140
1971	1637
1970	1914
1969	2290
1968	1855
1967	2305
1966	3740
1965	3730
1964	10,504
1963	4566
1962	3543
1961	5486
1960	4445

TABLE 4-15
(Continued)

Fiscal Year[a]	Total Uranium in Wastewater Discharge (kg)
1959	6488
1958	3712
1957	2595
1956	1485
1955	657
1954	347
1953	106
1952	11
	74,308

[a]1952 through 1976, the fiscal year is from July 1 through June 31 of the next year. 1976A is a three month transition period, July 1, 1976 through September 30, 1976. From 1977 to the present time, the fiscal year is from October 1 through September 30 of the next year.

SOURCE: "History of FMPC Radionuclide Discharges," National Lead of Ohio, Inc., 1985, Feed Materials Production Center, Cincinnati, OH.

TABLE 4-16

RADIONUCLIDES IN WASTEWATER DISCHARGES

Calendar Year	Thorium (kg)	Curies Discharged								
		Sr-90	Tc-99	Ru-106	Cs-137	Ra-226	Ra-228	Np-237	Pu-238	Pu-239/240
1957	-[a]	-	-	-	0.5	-	-	-	-	-
1958	-	-	-	-	-	0.5	-	-	-	-
1959	-	-	-	-	-	0.5	-	-	-	-
1960	-	-	-	-	-	0.5	-	-	-	-
1961	-	-	-	-	-	0.5	-	-	-	-
1962	-	-	-	-	-	0.5	-	-	-	-
1963	-	-	-	-	-	0.5	-	-	-	-
1964	-	-	-	-	-	0.5	-	-	-	-
1965	-	-	-	-	-	0.5	-	-	-	-
1966	-	-	-	-	-		-	-	-	-
1967	27	-	-	-	-	0.5	-	-	-	-
1968	128	-	-	-	-	0.5	1.1	-	-	-
1969	63	-	5.0	-	-	0.2	1.6	-	-	-
1970	29	-	2	-	-	0.2	0.5	-	-	-
1971	30	-	20	-	-	0.1	4×10^{-2}	-	-	-

TABLE 4-16
(Continued)

Calendar Year	Thorium (kg)	Curies Discharged								
		Sr-90	Tc-99	Ru-106	Cs-137	Ra-226	Ra-228	Np-237	Pu-238	Pu-239/240
1972	18	-	7.2	-	-	5.5×10^{-2}	1.5×10^{-2}	-	-	-
1973	9	-	6.2	-	-	2.4×10^{-2}	6×10^{-3}	-	-	-
1974	18	-	[b]	-	-	8×10^{-3}	6×10^{-3}	-	-	-
1975	6.4	-	[b]	-	-	1.3×10^{-2}	1.6×10^{-2}	-	-	-
1976	5.5	-	9	3×10^{-3}	2×10^{-2}	7×10^{-3}	8×10^{-3}	2×10^{-7}	4×10^{-7}	2×10^{-7}
1977	5.1	7.5×10^{-2}	0.1	8.2×10^{-3}	8.4×10^{-2}	7.2×10^{-3}	6.9×10^{-2}	$<5 \times 10^{-4}$	$<2.5 \times 10^{-5}$	$<5.6 \times 10^{-5}$
1978	5.5	6.9×10^{-3}	0.1	1.1×10^{-2}	1.5×10^{-2}	3.2×10^{-3}	4.3×10^{-3}	3.2×10^{-5}	$<2.4 \times 10^{-5}$	$<3.3 \times 10^{-5}$
1979	7.0	3.2×10^{-3}	3.4	1.8×10^{-3}	6.1×10^{-3}	7.8×10^{-4}	9.3×10^{-3}	1.9×10^{-4}	1.0×10^{-5}	2.9×10^{-5}
1980	2.1	2.6×10^{-3}	0.9	8.9×10^{-4}	1×10^{-2}	3.5×10^{-4}	3.3×10^{-3}	$<1 \times 10^{-4}$	3.8×10^{-6}	1.4×10^{-3}
1981	3.0	2.5×10^{-3}	4.2	6.7×10^{-4}	2.3×10^{-3}	1.1×10^{-2}	7×10^{-3}	$<1.4 \times 10^{-4}$	5.1×10^{-6}	2.9×10^{-5}
1982	3.8	3.2×10^{-3}	9.8	3.4×10^{-5}	2.8×10^{-3}	2.9×10^{-3}	1.2×10^{-2}	3×10^{-4}	4.9×10^{-6}	1.5×10^{-5}
1983	2.1	6.0×10^{-3}	21	3×10^{-4}	5.6×10^{-3}	1×10^{-3}	6×10^{-3}	$<2 \times 10^{-4}$	5×10^{-6}	8×10^{-5}
1984	4.5	1.2×10^{-2}	19	5×10^{-4}	1.7×10^{-2}	$<1.7 \times 10^{-2}$	$<1.4 \times 10^{-2}$	2×10^{-4}	3×10^{-5}	5×10^{-5}

[a]A dash indicates data were not collected.

[b]Data were collected but could not be retrieved.

Source: "History of FMPC Radionuclide Discharges," National Lead Company of Ohio, 1985, Feed Materials Production Center, Cincinnati, Ohio.

TABLE 4-17
SURFACE WATER SAMPLE TOTAL URANIUM AND THORIUM CONCENTRATIONS

Sample Location	Sample Date	Total Uranium (pCi/ℓ)	Total Thorium (pCi/ℓ)	Water Course
R1	03/07/86	1.42	0.24	Great Miami River
R1	03/25/86	1.41	0.34	Great Miami River
R2	03/07/86	1.60	0.62	Great Miami River
R2	03/25/86	1.06	0.08 MDC	Great Miami River
R3	03/07/86	0.15 MDC[a]	0.22	Great Miami River
R3	03/25/86	0.13	0.09 MDC	Great Miami River
R4	03/07/86	0.40	0.24	Great Miami River
R4	03/25/86	1.23	0.07 MDC	Great Miami River
P1	03/09/86	0.16 MDC	0.00 MDC	Paddys Run
P2	03/09/86	7.06	0.07 MDC	Paddys Run
P2	03/24/86	5.27	0.24 MDC	Paddys Run
P2	03/24/86	5.12	0.34	Paddys Run
P3	03/09/86	5.18 MDC	0.16 MDC	Paddys Run
P4	03/09/86	0.95	0.10 MDC	Paddys Run
P4	04/22/86	5.55	0.09 MDC	Paddys Run

TABLE 4-17
(Continued)

Sample Location	Sample Date	Total Uranium (pCi/ℓ)	Total Thorium (pCi/ℓ)	Water Course
P5	03/09/86	4.18	1.86	Paddys Run
P5	04/22/86	1.03	0.20	Paddys Run

[a]MDC - indicates less than Minimum Detection Concentration.

Source: IT Corporation, 1986, "Interim Report - Air, Soil, Water, and Health Risk Assessment in the Vicinity of FMPC, Fernald, Ohio."

TABLE 4-18

SEDIMENT SAMPLE TOTAL URANIUM AND THORIUM CONCENTRATIONS

Sample Location	Sample Date	Total Uranium (pCi/g)	Total Thorium (pCi/g)	Water Course
R1	03/07/86	0.96	2.19	Great Miami River
R2	03/07/86	0.80	0.97	Great Miami River
R3	03/07/86	0.44	1.92	Great Miami River
R4	03/07/86	0.80	1.58	Great Miami River
P1	03/24/86	0.82	1.22	Paddys Run
P2	03/09/86	0.76	1.08	Paddys Run
P2	03/09/86	0.76	1.17	Paddys Run
P3	03/24/86	0.96	0.61	Paddys Run
P4	03/24/86	1.44	1.14	Paddys Run
P4	03/24/86	0.24	0.56	Paddys Run
P5	03/09/86	0.70	1.83	Paddys Run

Source: IT Corporation, 1986, "Interim Report - Air, Soil, Water, and Health Risk Assessment in the Vicinity of FMPC, Fernald, Ohio."

in 1987. An advisory against eating bottom-feeding fish from the Great Miami River was issued by ODH as a result of this spill.

"FMPC Sampling and Analysis Report," DOE (1988)

Surface Water

Four surface water samples were collected from the Great Miami River and one sample was collected from a nearby gravel pit for this study. Radioactivity was measured in the field at background (Table 4-19). Temperature and specific conductivity were relatively consistent among samples (Table 4-19). Only those analytes measured above the minimum detection levels were reported. Barium was the only RCRA metal detected, at less than 1.0 mg/ℓ in all samples. The upstream sample had the highest concentration, with a general decrease observed downstream. Four organic compounds were detected, but all except 1,1,1-trichloroethane were also detected in the blank.

Total uranium increased downstream of the confluence of Paddys Run and thorium-227 had a minor increase over upstream levels immediately downstream of the effluent discharge, but was not detected further downstream (Table 4-19). To improve the understanding of surface water chemistry in the FEMP vicinity, a surface water sample was collected from a gravel pit located in the floodplain of the Great Miami River. All constituents except thorium-227 were below background levels.

Sediments

Radioactivity in sediment samples was consistent with previously identified background levels. As was reported for the surface water samples, the only RCRA metal detected in the sediment samples was barium (Table 4-20). The three organic compounds detected were also detected in the blank. Radionuclides were observed at higher concentrations in the sample from upstream of the effluent discharge (Table 4-20).

A Compilation of U.S. Geological Survey Water-Quality Data Collected from the Great Miami River Gaging Station at New Baltimore, Ohio for the Years 1985 - 1990.

Surface Water

NASQAN data indicate that arsenic, manganese, and zinc were detected in low concentrations in nearly every sample collected at this location, while other constituents such as cobalt and vanadium were not detected during the five-year period (Table 4-21). The other reported constituents were typically detected in less than 50 percent of the samples. For those constituents that have OEPA Water Quality Standards for aquatic life, only mercury appears to have exceeded this criterion, once. The average mercury concentration for this period was below the standard. No sediment data were collected.

TABLE 4-19

RADIOACTIVITY AND FIELD PARAMETERS
OFF-PROPERTY SURFACE WATER SAMPLING FOR GREAT MIAMI RIVER

	Upstream of FEMP Outfall	Gravel Pit	Between FEMP Outfall and Paddys Run		Downstream of Paddys Run
Sample ID Parameter	0415	0422	0416	0419	0420
Radioactivity (μR/hr)	Bkg[a]	Bkg	Bkg	Bkg	Bkg
pH	8.6	8.2	8.4	8.5	8.3
Temperature (C°)	23.9	25.2	24.3	24.2	24.2
Conductance (MS)	0.74	0.50	0.69	0.68	0.65
Organics (μg/ℓ):					
Acetone	17BM[bc]	12BM	12BM	---[d]	11BM
Methylene Chloride	8BM	---	9BM	---	---
1,1,1-Trichloroethane	---	---	7.0M	---	---
Toluene	---	---	5BM	---	---
Radionuclides:					
Total Uranium (μg/ℓ)	2.10M	1.70M	2.40M	2.40M	12.00M
Thorium-227 (pCi/ℓ)	0.08	0.39	0.98	---	---

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TABLE
(Continued)

Sample ID Parameter	Upstream of FEMP Outfall 0415	Gravel Pit 0422	Between FEMP Outfall and Paddys Run 0416	0419	Downstream of Paddys Run 0420
RCRA Metals: (mg/ℓ):					
Barium	0.53M	0.24DM	0.40M	0.16M	0.16M

Source: Department of Energy, 1988. "Feed Materials Production Center, Sampling and Analysis Document."

[a]Background levels.

[b]B = Analyte was found in the blank as well as the sample.

[c]M = Greatest value from multiple analyses of sample.

[d]Indicates sample concentration below MDL.

Source: Department of Energy, 1988. "Feed Materials Production Center, Sampling and Analysis Document."

TABLE 4-20
RADIOACTIVITY FOR OFF-PROPERTY SEDIMENT SAMPLING FOR GREAT MIAMI RIVER

Sample ID / Parameter	Upstream of FEMP Outfall	Between FEMP Outfall and Paddys Run		Downstream of Paddys Run
	0728[a]	0417	0418	0421
Radioactivity (μR/hr)	---[b]	Bkgd[c]	Bkgd	Bkgd
Organics (mg/kg):				
Acetone	NS (23B)[d,e]	39	33	---
Methylene Chloride	NS (15B)	6B	6B	6B
Chloroform	--- (6B)	---	---	---
Radionuclides (pCi/g):				
Uranium-235	0.09	---	---	---
Bismuth-214	0.84	---	0.38	0.65
Cesium-137	0.15	---	---	---
Neptunium-237	1.8	NS	NS	NS
Plutonium-238	2.4	NS	NS	NS
Plutonium-239/240	0.4	NS	NS	NS
Radium-226	1.1	---	0.28	0.6
Thorium-227	0.70	NS	NS	NS
Thorium-228	0.57G (0.40A)[f]	0.27	---	---
Thorium-230	0.5	NS	NS	NS
Thorium-232	0.59G (0.30A)	0.28	---	0.24
Total Uranium (mg/kg)	NS	0.96	0.83	1.30

See footnotes at end of table.

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TABLE 4-20
(continued)

Sample ID Parameter	Upstream of FEMP Outfall	Between FEMP Outfall and Paddys Run		Downstream of Paddys Run
	0728[a]	0417	0418	0421
RCRA Metals (mg/L):				
Barium	NS	1.17	0.91	0.99

[a]Number in parentheses indicate additional sample at same sampling location.

[b]For radioactivity indicates not applicable. For organics and radionuclides indicates sample concentration below MDL.

[c]Background levels.

[d]NS = Sample not analyzed for indicated analyte.

[e]B = Analyte was found in blank as well as the sample.

[f](A) = Alpa spectroscopy.
(G) = Gamma spectroscopy.

Source: Department of Energy, 1988. "Feed Materials Production Center, Sampling and Analysis Document."

TABLE 4-21
CONSTITUENTS OF POTENTIAL CONCERN IN SURFACE WATERS RECORDED IN THE GREAT MIAMI RIVER, NEW BALTIMORE, OHIO 1985 - 1990[a]

Constituent	Frequency of Detection	Arithmetic Mean (µg/ℓ)[b]	SD[c]	Range (µg/ℓ)[d]	OEPA Criterion (µg/ℓ)[e]
Aluminum	15/22	69	135	10 - 500	NC[f]
Arsenic	21/22	1.4	0.5	1 - 2	190
Beryllium	4/22	0.5	0.5	0.5 - 1	71
Cadmium	6/22	1.2	1.1	1 - 6	2.4
Chromium	8/22	1.6	1.1	1 - 5	370
Cobalt	0/22	3[g]	ND[h]	ND	NC
Lead	6/22	3.8	2.6	1 - 10	17
Manganese	22/22	9.8	12	1 - 50	NC
Mercury	4/22	0.1	0.1	0.1 - 0.7	0.2
Vanadium	0/22	6[g]	ND	ND	NC
Zinc	22/22	14	7.1	3 - 32	190

[a]Calculated from data supplied by USGS (1990, 1991) for the NASQAN station at New Baltimore, OH.

[b]Mean calculated for the 22 samples taken in 1985 - 1990. The detection limit was assumed to be the concentration for samples reported as below the detection limit.

[c]SD = standard deviation

[d]The minimum is the detection limit for all constituents but manganese and zinc.

[e]OEPA Water Quality Criteria for warm water habitat aquatic life use (OEPA 1990). Criteria for beryllium, cadmium, chromium, lead, and zinc are hardness-dependent, increasing as hardness increases. A hardness of 200 µg/ℓ as $CaCO_3$ was assumed, approximately the lower limit in the Great Miami River.

[f]NC = no criterion published by OEPA.

[g]The constituent was not detected in any sample. The value reported is the detection limit.

[h]ND = not detected. Therefore, no standard deviation or range is reported.

Quality Monitor - An Appraisal of Conditions in the Ohio River and Some of Its Tributaries, (quarterly water quality reports), Ohio River Sanitation Commission (ORSANCO), (1989 - 1991).

Surface Water

The information provided in the ORSANCO quarterly reports is similar to that presented in the NASQAN summary. The reported constituents include the concentrations of such water quality parameters as suspended solids and total hardness, in addition to phenol, free cyanide, and several dissolved metals. The ORSANCO data allow for comparison with the upstream New Baltimore data (Table 4-22).

At the time of this report, fourth quarter data for 1991 were not available. Since only two quarters of data collected at the Cleves location were available for review, detailed comparisons to the Elizabethtown data are not possible, but there appear to be no obvious chemical differences between these two sampling locations.

The quarterly reports present the results of the monthly samples. ORSANCO has adopted dual criteria for several substances to protect against chronic (long term) and acute (short term) toxicity to aquatic life. The criteria for cadmium, copper, lead, and zinc vary with water hardness. Both copper and zinc appear to have equalled or exceeded their respective criteria (Table 4-22), but the in the table are for a specific water hardness of 100 mg/ℓ, lower than the typical hardness levels observed for this reach of the Great Miami River.

From 1989 to 1991, concentrations of a few metals exceeded the ORSANCO Aquatic Life Criteria. At Elizabethtown, the cadmium criterion was exceeded in October 1989, and the lead criterion was exceeded in April 1990. Because of the analytical detection levels for mercury and the relatively low chronic aquatic life criterion, any detectable concentration of mercury will exceed the chronic criterion. There were no major differences between ORSANCO and NASQAN data. No sediment data were collected.

RI/FS Sampling and Analysis

A high percentage of the data were below analytical detection limits for essentially every parameter analyzed. The following sections focus on each analytical detection in the samples from the various streams.

Surface Water

Radionuclides in Surface Water

Isotopic uranium was detected in only one sample from upstream of the effluent discharge, although total uranium was detected in half the samples (Table 4-23). The range of downstream uranium concentrations was approximately twice that of upstream. These results are consistent with the FEMP

TABLE 4-22

CHEMICAL DATA COLLECTED FOR THE GREAT MIAMI RIVER DOWNSTREAM OF THE FEMP 1989 - 1991

Variable[d]	Elizabethtown R.M. 5.5[a]		Cleves R.M. 7.9[b]		ORSANCO Aquatic Life Criteria[c]	
	No. Samples	Range	No. Samples	Range	Chronic (µg/ℓ)	Acute (µg/ℓ)
Suspended solids (mg/ℓ)	26	4 - 344	6	33 - 111	NA[e]	NA
Total hardness (mg/ℓ)	26	132 - 336	6	192 - 308	NA	NA
Aluminum	26	40 - 15,000	6	550 - 965	NA	NA
Arsenic	26	<0.5 - 5.9	6	<2.0 - 14.3	190[f]	360[f]
Cadmium (µg/ℓ)[g]	25	<1 - 7	6	<0.5 - <3	1.1[h]	3.9[h]
Chromium (hexavalent)	9	<10 - <50	2	<15 - <25	11	16
Copper[i]	25	1 - 20	6	5 - 15	12[h]	18[h]
Cyanide (free)	25	<1 - 8	6	<1 - <2	5.2	22
Iron	26	20 - 11,000	6	820 - 1770	1000	NA
Lead[j]	26	<10 - 50	6	<5 - <50	3.2[h]	82[h]
Manganese	26	10 - 220	6	68 - 110	NA	NA
Mercury[k]	26	<0.1 - 1.3	6	<0.2 - 0.3	0.012	2.4
Phenol (µg/ℓ)	25	<2 - 9	6	2 - 51	2580[l]	10,200[l]
Zinc	26	<5 - 120	6	<20 - 69	120[h]	110[h]

TABLE 4-23

RADIONUCLIDES DETECTED DURING RI/FS SAMPLING OF GREAT MIAMI RIVER SURFACE WATER

Radionuclide	Parameters	Upstream of the Confluence with the FEMP Main Effluent Line	Between the Effluent Discharge and the Confluence with Paddys Run	Downstream of Confluence with Paddys Run
Ra-226	Range (pCi/ℓ)	2.4-2.4	ND[b]	ND
	Mean[a] (pCi/ℓ)	0.65	ND	ND
	Frequency of Detection	1/13	ND	ND
Ra-228	Range (pCi/ℓ)	ND	ND	5.0-5.0
	Mean (pCi/ℓ)	ND	ND	1.83
	Frequency of Detection	ND	ND	1/12
Tc-99	Range (pCi/ℓ)	ND	40.1-95.9	ND
	Mean (pCi/ℓ)	ND	20.3	ND
	Frequency of Detection	ND	2/20	ND
Th-228	Range (pCi/ℓ)	1.5-1.5	1.5-1.8	2.6-2.6
	Mean (pCi/ℓ)	0.58	0.62	0.68
	Frequency of Detection	1/13	2/20	1/12
Th-230	Range (pCi/ℓ)	ND	ND	1.3-1.3
	Mean (pCi/ℓ)	ND	ND	0.57
	Frequency of Detection	ND	ND	1/12
U-234	Range (pCi/ℓ)	1.1-1.1	1.1-2.2	1.0-1.8
	Mean (pCi/ℓ)	0.55	0.99	0.88
	Frequency of Detection	1/13	9/20	5/12
U-238	Range (pCi/ℓ)	ND	1.0-1.9	1.0-2.0
	Mean (pCi/ℓ)	ND	0.9	0.78
	Frequency of Detection	ND	9/20	3/12
Total Uranium	Range (µg/ℓ)	1.0-2.0	1.0 - 5.0	2.0 - 5.0
	Mean (µg/ℓ)	1.0	3.0	3.0
	Frequency of Detection	6/11	20/20	12/12

[a]If the distribution is normal or if the distribution is log-normal, the number of detects $\geq$ 7, and frequency of detection $\geq$ 50%, an arithmetic mean is given. If the distribution is log-normal and either the number of detects < 7 or the frequency of detection is < 50%, a geometric mean is given. Details of statistical analyses are described in the Risk Assessment Work Plan Addendum (DOE 1992a).
[b]Not detected.

monitoring data discussed above. Only three other radionuclides were detected, and these detections were sporadic (Table 4-23).

General Chemistry and Metals in Surface Water

The major chemical composition of the river is similar to that of groundwater. Calcium is the dominant cation, followed by magnesium, sodium, and potassium (Table 4-24). Carbonate, i.e., alkalinity, was not measured in the RI/FS samples. However, similar to groundwater (Section 4.1.4), carbonate is likely the dominant anionic constituent, followed by sulfate, chloride, and nitrate. The concentrations of several anionic species, including chloride and nitrate, are quite variable. This may be due to the wide range of flow conditions over which sampling occurred, or could reflect seasonal watershed activities such as road-salting and farming. The concentrations of iron and manganese detected in Great Miami River water are consistent with a well-oxygenated condition expected in free-flowing, relatively shallow river systems. No heavy metal concentrations are elevated in river water at downstream stations relative to observed concentrations at upstream background stations.

Sediments

Radionuclides in Sediments

Radionuclides detected in sediment samples from the Great Miami River exhibited no obvious spatial pattern (Table 4-25). Total uranium concentrations were consistently less than or equal to 3 μg/g at all sampling stations, with no discernible difference upstream and downstream from either the effluent discharge or the confluence of Paddys Run with the river. Radium isotopes were also periodically detected at all sampling locations, ranging from 0.4 to 0.9 pCi/g. A similar range occurred at upstream and downstream stations. Thorium-230 and strontium-90 were also periodically detected both upstream and downstream from FEMP influence, with no obvious spatial pattern.

4.1.3.2 Paddys Run

NLO (1980 - 1985) and WMCO (1986 - 1991), Environmental Monitoring Annual Reports

Paddys Run surface water and sediments have been sampled under the FEMP monitoring program since 1979 at six stations (Figure 3-10). Stations W5 and W9, upstream of the FEMP, are considered background stations. Station W10 is the downstream station for the waste storage area and is located south of the K-65 silo area. Stations W11 and W7 are upstream and downstream from the confluence of Paddys Run with the SSOD. Station W8 is off-property to the south of the FEMP and is sampled when Station W7 is dry. Sampling locations W9, W10, and W11 were added in 1985 to better evaluate the impact of surface runoff from the waste pit area and the SSOD.

Surface Water

Radionuclide concentrations at Station W5 were generally lower than those at downstream stations (Table 4-26). However, radionuclide concentrations in Paddys Run have wide ranges which exceed the average value for a given location. This is probably due to short-term changes in the water quality

TABLE 4-24

CHEMICALS AND GENERAL PARAMETERS DETECTED DURING RI/FS SAMPLING OF GREAT MIAMI RIVER SURFACE WATER

Chemical	Parameters	Upstream of the Confluence with the FEMP Main Effluent Line	Between the Effluent Discharge and the Confluence with Paddys Run	Downstream of the Confluence with Paddys Run
Ammonia	Range (mg/ℓ)	0.1-1.9	0.188-1.400	0.2-0.8
	Mean[a] (mg/ℓ)	0.29	0.5	0.46
	Frequency of Detection	6/6	7/10	5/6
Arsenic	Range (mg/ℓ)	ND[b]	0.002-0.002	ND
	Mean (mg/ℓ)	ND	0.001	ND
	Frequency of Detection	ND	1/3	ND
Barium	Range (mg/ℓ)	0.05-0.05	0.048-0.049	0.038-0.038
	Mean (mg/ℓ)	[c]	0.048	[c]
	Frequency of Detection	2/2	3/3	2/2
Cadmium	Range (mg/ℓ)	0.003-0.10	0.003-0.003	0.002-0.002
	Mean (mg/ℓ)	[c]	0.003	[c]
	Frequency of Detection	2/2	3/3	2/2
Calcium	Range (mg/ℓ)	61.200-63.400	60.6-61.9	48.6-49.2
	Mean (mg/ℓ)	[c]	61.1	[c]
	Frequency of Detection	2/2	3/3	2/2
Chloride	Range (mg/ℓ)	17.990-325.00	16.0-252	10.0-154
	Mean (mg/ℓ)	140	112	59.340
	Frequency of Detection	6/6	10/10	6/6
Chromium	Range (mg/ℓ)	0.006-0.006	0.004-0.004	ND
	Mean (mg/ℓ)	[c]	0.002	ND
	Frequency of Detection	1/2	1/3	ND
Copper	Range (mg/ℓ)	0.009-.0.12	0.010-0.014	0.006-0.007
	Mean (mg/ℓ)	[c]	0.011	[c]
	Frequency of Detection	2/2	3/3	2/2
Fluoride	Range (mg/ℓ)	0.260-0.900	0.29-0.90	0.25-0.90
	Mean (mg/ℓ)	0.67	0.69	0.56
	Frequency of Detection	6/6	10/10	6/6

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TABLE 4-24
(Continued)

Chemical	Parameters	Upstream of the Confluence with the FEMP Main Effluent Line	Between the Effluent Discharge and the Confluence with Paddys Run	Downstream of the Confluence with Paddys Run
Iron	Range (mg/ℓ)	0.164-0.216	0.175-0.194	0.410-0.522
	Mean (mg/ℓ)	c	0.19	c
	Frequency of Detection	2/2	3/3	2/2
Lead	Range (mg/ℓ)	0.002-0.005	0.002-0.003	0.005-0.006
	Mean (mg/ℓ)	c	0.003	c
	Frequency of Detection	2/2	3/3	2/2
Magnesium	Range (mg/ℓ)	21.4-21.5	21.2-21.4	16.4-16.5
	Mean (mg/ℓ)	c	21.3	c
	Frequency of Detection	2/2	3/3	2/2
Manganese	Range (mg/ℓ)	0.009-0.010	0.008-0.009	0.011-0.012
	Mean (mg/ℓ)	c	0.009	c
	Frequency of Detection	2/2	3/3	2/2
Mercury	Range (mg/ℓ)	0.001-0.010	0.001-0.001	0.001-0.002
	Mean (mg/ℓ)	c	0.0	c
	Frequency of Detection	2/2	1/3	2/2
Molybdenum	Range (mg/ℓ)	0.007-0.007	ND	ND
	Mean (mg/ℓ)	c	ND	ND
	Frequency of Detection	1/2	ND	ND
Nickel	Range (mg/ℓ)	0.011-0.013	0.011-0.011	0.007-0.007
	Mean (mg/ℓ)	c	0.011	0.007
	Frequency of Detection	2/2	3/3	1/2
Nitrate	Range (mg/ℓ)	0.400-8.270	0.400-7.68	0.8-4.12
	Mean (mg/ℓ)	3.71	3.34	2.18
	Frequency of Detection	6/6	10/10	4/6
Phenols	Range (mg/ℓ)	0.01-0.01	0.01-0.03	0.02-0.02
	Mean (mg/ℓ)	0.008	0.012	0.008
	Frequency of Detection	3/6	5/10	1/6

TABLE 4-24
(Continued)

Chemical	Parameters	Upstream of the Confluence with the FEMP Main Effluent Line	Between the Effluent Discharge and the Confluence with Paddys Run	Downstream of the Confluence with Paddys Run
Phosphate	Range (mg/ℓ)	1.1-3.9	0.56-1.10	2.3-4.9
	Mean (mg/ℓ)	[c]	0.89	[c]
	Frequency of Detection	2/2	3/3	2/2
Phosphorous (black, white, red)	Range (mg/ℓ)	0.299-0.900	0.050-0.386	0.050-1.34
	Mean (mg/ℓ)	0.49	0.22	0.9
	Frequency of Detection	4/4	7/7	4/4
Potassium	Range (mg/ℓ)	2.3-2.9	2.09-2.27	2.17-2.26
	Mean (mg/ℓ)	[c]	2.21	[c]
	Frequency of Detection	2/2	3/3	2/2
Selenium	Range (mg/ℓ)	ND	ND	0.002-0.002
	Mean (mg/ℓ)	ND	ND	[c]
	Frequency of Detection	ND	ND	1/2
Sodium	Range (mg/ℓ)	12.9-13.5	12.2-13.2	12.8-13.2
	Mean (mg/ℓ)	[c]	12.7	[c]
	Frequency of Detection	2/2	3/3	2/2
Sulfate	Range (mg/ℓ)	78.220-4310.0	81.00-132.00	87-192
	Mean (mg/ℓ)	203.59	103.65	134
	Frequency of Detection	6/6	10/10	6/6
Total kjeldahl nitrogen	Range (mg/ℓ)	1.48-1.84	1.25-1.48	2.62-3.12
	Mean (mg/ℓ)	[c]	1.36	[c]
	Frequency of Detection	2/2	3/3	2/2
Total organic carbon	Range (mg/ℓ)	18.5-25.7	19.5-22.7	19.0-21.2
	Mean (mg/ℓ)	[c]	21.3	[c]
	Frequency of Detection	2/2	4/4	2/2
Total organic halides	Range (mg/ℓ)	0.019-0.190	0.018-0.160	0.016-0.110
	Mean (mg/ℓ)	0.068	0.061	0.046
	Frequency of Detection	4/6	7/10	4/6

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TABLE 4-24
(Continued)

Chemical	Parameters	Upstream of the Confluence with the FEMP Main Effluent Line	Between the Effluent Discharge and the Confluence with Paddys Run	Downstream of the Confluence with Paddys Run
Total organic nitrogen	Range (mg/ℓ)	0.200-1.730	0.100-1.375	1.00-2.71
	Mean (mg/ℓ)	0.92	0.70	1.19
	Frequency of Detection	6/6	9/10	4/6

[a]If the distribution is normal or if the distribution is log-normal, the number of detects ≥ 7. and frequency of detection ≥ 50%, an arithmetic mean is given. If the distribution is log-normal and either the number of detects < 7 or the frequency of detection is < 50%, a geometric mean is given. Details of statistical analyses are described in the Risk Assessment Work Plan Addendum (DOE 1992a).
[b]Not detected.
[c]Not applicable if sample size is ≤ 2.

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TABLE 4-25

RADIONUCLIDES DETECTED DURING RI/FS SAMPLING OF GREAT MIAMI RIVER SEDIMENTS

Radionuclide	Parameters	Upstream of the Confluence with the FEMP Effluent Line	Between the FEMP Effluent Line Confluence and the Confluence with Paddys Run	Downstream of the Confluence with Paddys Run
Radium-226	Range (pCi/g)	0.4-0.7	0.385-0.8	0.4-0.912
	Mean[a] (pCi/g)	0.507	0.516	0.549
	Detection Frequency	6/6	9/9	6/6
Radium-228	Range (pCi/g)	ND[b]	0.6-0.6	ND
	Mean (pCi/g)	ND	0.289	ND
	Detection Frequency	ND	1/9	ND
Strontium-90	Range (pCi/g)	0.7-0.7	0.6-0.8	0.6-0.6
	Mean (pCi/g)	0.4	0.411	0.308
	Detection Frequency	2/6	3/9	1/6
Thorium-230	Range (pCi/g)	0.7-1.9	0.8-2.3	0.7-1.5
	Mean (pCi/g)	0.883	1.033	0.817
	Detection Frequency	3/6	6/9	4/6
Total Thorium	Range (pCi/g)	2.0-3.0	2.0-3.0	2.0-2.0
	Mean (pCi/g)	[c]	2.333	[c]
	Detection Frequency	2/2	3/3	2/2
Uranium-234	Range (pCi/g)	0.6-0.6	0.7-1.4	0.6-0.7
	Mean (pCi/g)	0.35	0.511	0.417
	Detection Frequency	1/6	3/9	2/6
Uranium-238	Range (pCi/g)	0.6-0.6	0.6-1.1	0.7-0.9
	Mean (pCi/g)	0.35	0.478	0.467
	Detection Frequency	1/6	3/9	2/6
Total Uranium	Range (pCi/g)	1.0-3.0	1.0-3.0	1.0-3.0
	Mean (pCi/g)	2.0	2.0	2.25
	Detection Frequency	4/4	9/9	4/4

[a]If the distribution is normal or if the distribution is log-normal, the number of detects $\geq$ 7, and frequency of detection $\geq$ 50%, an arithmetic mean is given. If the distribution is log-normal and either the number of detects < 7 or the frequency of detection is < 50%, a geometric mean is given. Details of statistical analyses are described in the Risk Assessment Work Plan Addendum (DOE 1992a).
[b]Not detected.
[c]Not applicable if sample size is $\leq$ 2.

TABLE 4-26

RADIONUCLIDES IN SURFACE WATER OF PADDYS RUN ENVIRONMENTAL MONITORING ANNUAL REPORTS, 1976-1990

	Sample Location					
Radionuclide	W5	W7	W8	W9	W10	W11
Gross Alpha						
Years	1979-1988	1979-1988	1979-1988	1985-1988	1985-1988	1985-1988
Concentration Range (pCi/ℓ)	0.45-56.0	0.77-639	<0.9-93	<0.45-41.89	0.81-824	0.90-416
Number of Samples	513	249	250	137	104	74
Average Concentration[a] (pCi/ℓ)	1.7	15.5	8	4	14.6	10.4
Gross Beta						
Years	1979-1988	1979-1988	1979-1988	1985-1988	1985-1988	1985-1988
Concentration Range (pCi/ℓ)	0.90-90.0	1.8-144	1.4-87	00.54-17.12	0.81-369	3.6-164
Number of Samples	513	249	250	137	104	74
Average Concentration (pCi/ℓ)	7.3	12.4	16.5	6.4	10.5	12.2
Radium-226						
Years	1980-1990	1980-1990	1986-1990	1985-1990	1985-1990	1985-1990
Concentration Range (pCi/ℓ)	<0.001-0.9	0.00061-1.8	<0.001-0.90	NA[b]	NA	NA
Number of Samples	68	100	18	0	0	0
Average Concentration (pCi/ℓ)	0.2	0.2	0.2	NA	NA	NA
Radium-228						
Years	1980-1990	1980-1990	1986-1990	1985-1990	1985-1990	1985-1990
Concentration Range (pCi/ℓ)	<0.001->2.0	<0.001-<2.0	<0.001-1.2	NA	NA	NA
Number of Samples	68	100	18	0	0	0
Average Concentration (pCi/ℓ)	0.4	0.3	0.3	NA	NA	NA
Uranium						
Years	1979-1990	1979-1990	1979-1990	1985-1990	1985-1990	1985-1990
Concentration Range (pCi/ℓ)	0.3-11.51	0.3-718	0.3-112	0.27-176.02	1.1-1827.90	1.4-589
Number of Samples	614	350	290	235	179	136
Average Concentration (pCi/ℓ)	1.1	20	5.4	5.4	73.1	11

TABLE 4-26
(Continued)

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[a]Average concentration represents the mean of the annual average concentrations for the dates indicated.
[b]NA, Data not available or do not exist.

of Paddys Run associated with runoff from the waste storage area and other portions of the FEMP. Locations W9, W10, and W11 showed the highest single year averages of total uranium with concentrations of 23.33, 235.51, and 9.82 pCi/ℓ, respectively. The highest concentration of 1828 pCi/ℓ was observed at W10. There were no consistent differences between upstream or downstream concentrations of nitrate (Table 4-27). Fluoride, chloride, and pH were also generally consistent across stations.

Sediment

Results of Paddys Run sediment sampling can be divided into two groups: above the confluence with the SSOD and below the confluence (Table 4-28). Average and maximum uranium and technetium concentrations were higher below the confluence than above it, consistent with the values reported for the SSOD itself. Radium, thorium, and plutonium isotopes did not exhibit this pattern.

"Interim Report - Air, Soil, Water, and Health Risk Assessment in the Vicinity of the FEMP, Fernald, Ohio," IT (1986)

Surface Water

There was no clear spatial pattern in total uranium or thorium concentrations in these samples, although samples from locations downstream of the northern boundary of the FEMP (P2 - P5) had higher uranium concentrations that from upstream at P1 (Table 4-17).

Samples were also analyzed for a variety of metals, organic compounds, and other general chemical parameters. Most analyzed compounds were not detected, were not present in sufficient concentrations to constitute a detection, or were also present in the sample blank.

Sediment

There was no clear spatial pattern in total uranium or thorium concentrations in sediment, and the upstream sample, P1, was similar to downstream samples, P2 - P5 (Table 4-18). Most analyzed compounds were not detected, were not present in sufficient concentrations to constitute a detection (estimated), or were also present in the sample blank.

"FMPC Sampling and Analysis Report," DOE (1988)

Surface Water

Three surface water samples were collected on-property from Paddys Run and two from the SSOD (Table 4-29). The only analyte which showed any obvious pattern was total uranium, which increased in Paddys Run in the downstream direction. Total uranium was also detected in the SSOD samples.

Sediment

Ten sediment samples were collected from the Paddys Run/SSOD drainage system (Table 4-30). One sample (0412) was collected from a drainage ditch that receives runoff from the K-65 silo area. Three

TABLE 4-27

ION CONCENTRATIONS AND pH LEVELS IN SURFACE WATER OF PADDYS RUN ENVIRONMENTAL MONITORING ANNUAL REPORTS, 1985-1990

Parameter	Sample Location: W5	W7	W8	W9	W10	W11
Fluoride						
Years	1979-1990	1979-1990	1980-1990	1985-1990	1985-1990	1985-1990
Concentration Range (mg/ℓ)	0.10-0.70	0.1-2.5	0.10-0.8	0.10-2.0	0.10-1.0	0.2-1.1
Number of Samples	148	128	120	61	52	46
Average Concentration (mg/ℓ)	0.2	0.3	0.2	0.3	0.3	0.3
Nitrate						
Years	1979-1990	1979-1990	1980-1990	1985-1990	1985-1990	1985-1990
Concentration Range (mg/ℓ)	<0.10-15.0	<0.1-18.0	<0.10-7.1	<0.1-24	0.1-39	0.2-5.7
Number of Samples	145	125	116	61	52	46
Average Concentration (mg/ℓ)	2.7	3.2	1.0	2.0	1.8	2.4
Chloride						
Years	1979-1990	1979-1990	1980-1990	1985-1990	1985-1990	1985-1990
Concentration Range (mg/ℓ)	5.0-111.0	4.0-135.0	5.0-171	8-46	7-46	7-34
Number of Samples	138	123	112	53	44	38
Average Concentration (mg/ℓ)	29.2	21.9	36.5	26	22.8	21.3
pH						
Years (S.U.)[b]	1979-1990	1979-1990	1980-1990	1985-1990	1985-1990	1985-1990
Concentration Range	6.9-8.7	6.9-8.8	7.0-8.5	7.5-8.6	7.6-8.8	7.5-8.7
Number of Samples (S.U.)	572	297	272	235	179	136
Average Concentration	8.0	8.3	7.8	8.2	8.2	8.3

[a]Average concentration represents the mean of the annual average concentrations for the dates indicated.
[b]Standard Units.

TABLE 4-28

RADIONUCLIDES IN SEDIMENTS OF PADDYS RUN ENVIRONMENTAL MONITORING ANNUAL REPORTS, 1983-1990

Radionuclide	Sample Location: Upstream of Storm Sewer Outfall Ditch	Downstream of Storm Sewer Outfall Ditch	Storm Sewer Outfall Ditch
Uranium-234			
Years	1986-1990	1986-1990	1986-1990
Concentration Range (pCi/g)	0.04-10	0.06-29	0.34-25
Number of Samples[a]	144	107	45
Average Concentration[b] (pCi/g)	1	1	4
Uranium-235/236			
Years	1986-1990	1986-1990	1986-1990
Concentration Range (pCi/g)	0.0014-<2.6	0.0074-3.4	0.024-2.6
Number of Samples[a]	144	107	45
Average Concentration (pCi/g)	0.2	0.2	0.3
Uranium-238			
Years	1986-1990	1986-1990	1986-1990
Concentration Range (pCi/g)	0.0007-8.7	0.04-37.0	0.44-38
Number of Samples[a]	144	107	45
Average Concentration (pCi/g)	0.8	1.5	5
Uranium-total			
Years	1983-1985	1983-1985	1983-1985
Concentration Range (pCi/g)	0.5-180.0	1.1-296.35	2.82-214.61
Number of Samples	24	7	24
Average Concentration (pCi/g)	15.3	75	48.73
Radium-223			
Years	1986	1986	1986
Concentration Range (pCi/g)	0.078-0.48	0.095-0.40	0.10-0.64
Number of Samples[a]	N/A	N/A	N/A
Average Concentration (pCi/g)	0.22	0.23	0.29
Radium-224			
Years	1986-1990	1986-1990	1986-1990
Concentration Range (pCi/g)	<0.0792-2.3	<0.032-1.7	0.064-<2.96
Number of Samples[a]	144	107	45
Average Concentration (pCi/g)	0.42	0.4	0.61

See footnotes at end of table.

TABLE 4-28
(Continued)

Radionuclide	Sample Location: Upstream of Storm Sewer Outfall Ditch	Downstream of Storm Sewer Outfall Ditch	Storm Sewer Outfall Ditch
Radium-226			
Years	1986-1990	1986-1990	1986-1990
Concentration Range (pCi/g)	0.14-4.5	<0.038-2.1	0.17-2.4
Number of Samples[a]	144	107	45
Average Concentration (pCi/g)	0.67	0.6	0.7
Radium-228			
Years	1986-1990	1986-1990	1986-1990
Concentration Range (pCi/g)	<0.154.2.0	<0.11-1.3	0.29-2.86
Number of Samples[a]	144	107	45
Average Concentration (pCi/g)	0.41	0.4	0.73
Thorium-228			
Years	1986-1990	1986-1990	1986-1990
Concentration Range (pCi/g)	0.04-5.1	0.0052-6.6	0.29-2.81
Number of Samples[a]	144	107	45
Average Concentration (pCi/g)	0.6	0.4	0.73
Thorium-230			
Years	1986-1990	1986-1990	1986-1990
Concentration Range (pCi/g)	0.22-9.8	0.21-11	0.30-4.7
Number of Samples[a]	144	107	45
Average Concentration (pCi/g)	0.7	1	1.0
Thorium-232			
Years	1986-1990	1986-1990	1986-1990
Concentration Range (pCi/g)	0.03-5.4	0.0094-1.3	0.13-3.4
Number of Samples[a]	144	107	45
Average Concentration (pCi/g)	0.4	0.4	0.6
Plutonium-238			
Years	1986-1990	1986-1990	1986-1990
Concentration Range (pCi/g)	0.0012-0.46	0.0050-0.090	<0.001-1.0
Number of Samples[a]	144	107	45
Average Concentration (pCi/g)	0.01	0.01	0.02
Plutonium-239/240			
Years	1986-1990	1986-1990	1986-1990
Concentration Range (pCi/g)	0.00099-0.52	0.0015-<0.12	<0.001-1.0
Number of Samples[a]	144	107	45
Average Concentration (pCi/g)	0.02	0.01	0.02

See footnotes at end of table.

TABLE 4-28
(Continued)

Radionuclide	Sample Location: Upstream of Storm Sewer Outfall Ditch	Downstream of Storm Sewer Outfall Ditch	Storm Sewer Outfall Ditch
Technetium-99			
Years	1983-1990	1983-1990	1983-1990
Concentration Range (pCi/g)	0.0-5.1	<0.58-38.0	0.11-17.0
Number of Samples[a]	150	110	51
Average Concentration (pCi/g)	1.1	10.8	5.6

[a]Number of samples is approximate; the number of samples from the 1986 through the 1988 sampling events are not available and are not included in this number.

[b]Average concentration is the mean of the annual average concentrations for the dates indicated.

TABLE 4-29

RADIOACTIVITY AND FIELD PARAMETERS FOR ON-PROPERTY SURFACE WATER SAMPLING FOR PADDYS RUN AND STORM SEWER OUTFALL DITCH

	Storm Sewer Outfall Ditch		Paddys Run		
Sample ID Parameter	0406	0407	0722	0723	0724
Temperature (°C)	---[a]	---	21.5	21.8	23.0
pH	---	---	6.0	5.0	5.5
Organics (µg/ℓ):					
Acetone	14B[b]	13B	---	---	---
Methylene Chloride	---	---	9B	7B	---
Radionuclides (pCi/ℓ):					
Neptunium-237	NS[c]	NS	---	---	0.04
Thorium-227	NS	NS	---	0.44	---
Total U (µg/ℓ)	67.0	12.0	6.9	25.0	27.0
RCRA Metals (mg/ℓ):					
Barium	0.08	0.18	0.08	0.07	0.06

[a]For temperature and pH indicates not applicable. For organics and radionuclides indicates sample concentration below MDL.

[b]B = Analyte was found in blank as well as sample.

[c]NS = Not analyzed.

Source: Department of Energy, 1988. "Feed Materials Production Center, Sampling and Analysis Document."

TABLE 4-30

DOE (1988) DATA FOR ON-PROPERTY SEDIMENT SAMPLES FROM PADDYS RUN AND STORM SEWER OUTFALL DITCH

	Paddys Run								Storm Sewer Outfall Ditch	
Sample ID Parameter	0410	0411	0401	0402	0412	0408	0409	0413	0405	0404
Radioactivity (μr/hr)	Bkgd[a]	Bkgd	200	450	Bkgd	---[b]	---	Bkgd	---	---
Organics:										
Acetone (mg/kg)	27	---	120Q[c]	27B[d]	52	14B	12	36	230Q	55B
2-Butanone (μg/kg)	---	---	---	---	---	10B	---	---	---	---
Methylene Chloride (μg/kg)	10B	13B	52	9B	12B	30B	21B	14B	55	32B
Radionuclides (pCi/g):										
Bismuth-214	0.71	0.81	0.58	1.10	1.60	0.48	0.47	0.51	0.59	0.41
Cesium-137	---	0.04	---	---	0.14	---	---	---	---	---
Uranium-235	---	---	---	---	1.30	---	---	---	---	0.26
Uranium-238	---	---	---	---	54.0	---	18.0	41.0	---	12.0
Neptunium-237	0.30	2.40	2.30	0.90	2.80	0.90	0.70	2.20	NS[e]	0.14
Plutonium-238	1.9	1.5	1.3	0.8	1.1	1.6	1.5	1.4	NS	---
Plutonium-239 & 240	0.3	0.3	0.3	0.1	0.2	0.3	0.3	0.4	NS	---
Radium-226	0.58	0.53	0.68	1.30	1.30	0.58	0.59	0.64	0.43	0.49
Radium-228	---	---	---	---	---	---	---	---	NS	NS
Thorium-227	0.20	0.60	0.20	0.20	0.50	0.20	2.70	1.30	0.49	0.51
Thorium-228[f]	0.73	0.57	0.73	1.20	2.00	0.61	0.32	0.60	—	—

TABLE 4-30
(Continued)

Sample ID Parameter	Paddys Run 0410	0411	0401	0402	0412	0408	0409	0413	Storm Sewer Outfall Ditch 0405	0404
Thorium-228[g]	0.30	0.80	0.30	0.40	1.10	0.10	0.40	0.60	NS	NS
Thorium-230	1.20	14.00	0.20	1.40	6.20	0.40	0.50	8.30	0.57	0.45
Thorium-232[f]	0.64	0.80	0.55	1.10	1.90	---	0.20	0.54	—	—
Thorium-232[g]	0.30	0.49	0.20	0.20	1.00	0.10	10.0	0.50	22.0	24.0
Total U (mg/kg)	1.4	2.0	10.0	12.0	176.0	6.3	0.23	38.0	0.43	0.28
RCRA Metals:										
Barium (mg/kg)	1.68	1.62	0.37B	0.77	1.02	0.31	—	0.39	—	—

[a]Background levels.

[b]Concentration below minimum detection limits.

[c]Q = Data of questionable value. Possible laboratory contamination.

[d]B = Analyte was found in blank as well as sample.

[e]NS = Not analyzed.

[f]Gamma Spectroscopy.

[g]Alpha Spectroscopy.

Source: Department of Energy, 1988. "Feed Materials Production Center, Sampling and Analysis Document."

samples (0411, 0401, and 0402) were collected along Paddys Run adjacent to the waste pit area, and other sample locations (0408, 0409, and 0413) were selected to determine the relative contribution of the SSOD (0404, 0405) to contaminants in Paddys Run. There was above background radioactivity at the locations immediately adjacent to and downstream of the waste pit area (Table 4-30). The organics detected were acetone, 2-butanone, and methylene chloride. However, for most of the detections, the compound was also detected in the analytical blank. Barium was the only RCRA metal detected, and all concentrations were lower than that in the most upstream (background) sample.

The highest concentrations of most radionuclides occurred in the sample collected from the K-65 drainage ditch (0412). The SSOD samples (0404 and 0405) had the highest thorium-232 concentration (using alpha spectroscopy). The samples collected near the waste pit area had detectable neptunium-237, total uranium. radium-226, and thorium-232 (gamma spectroscopy) and also recorded the highest thorium-230 concentration.

RI/FS Sampling and Analysis

Surface water and sediments in Paddys Run were sampled at Station W10 downstream from the Waste Storage Area, Station W11 upstream from the confluence with the SSOD, and Station W7 downstream from the confluence with the SSOD. In addition, sediment samples were collected from Station W5 upstream from the FEMP. Surface water samples were collected in January and May 1989, while sediment samples were collected in June and August 1988 and in April 1989. The lack of surface water in Paddys Run during the three rounds of sediment sampling prevented the concurrent sampling of surface water and sediment.

Surface Water

Uranium was detected in all but one sample (Table 4-31), with similar concentrations above and below the SSOD. Strontium-90 and thorium isotopes were the other radionuclides detected.

Paddys Run stream water is well-oxygenated and total dissolved solids (TDS) range between 400 and 500 mg/ℓ. The stream water is similar in major ion composition to groundwater. Calcium is the dominant cation, followed by magnesium and sodium (Table 4-32). Bicarbonate is the dominant anion, followed by sulfate, chloride, and nitrate. The primary nonradiological chemical composition of Paddys Run is comparable above and below the confluence with the SSOD.

Other metals and organics were either not detected or concentrations were very low. Samples collected in January 1989 no detections of HSL organic compounds. In May 1989, however, N-nitrosodiphenylamine was detected at Station W10 and diethyl phthalate was detected at Station W11. Each of these detections was, however, at concentrations below the contract required quantitation limit.

TABLE 4-31

RADIONUCLIDES DETECTED DURING RI/FS SAMPLING OF PADDYS RUN SURFACE WATER

Radionuclide	Parameters	Between the FEMP Northern Property Boundary and the Confluence with the Storm Sewer Outfall Ditch	Downstream of the Confluence with the Storm Sewer Outfall Ditch
Sr-90	Range (pCi/ℓ)	24.0-24.0	ND[b]
	Mean[a] (pCi/ℓ)	3.317	ND
	Frequency of Detection	1/8	ND
Th-228	Range (pCi/ℓ)	ND	1.78-4.5
	Mean (pCi/ℓ)	ND	0.924
	Frequency of Detection	ND	3/8
Th-230	Range (pCi/ℓ)	1.120-6.74	1.56-2.05
	Mean (pCi/ℓ)	1.148	0.826
	Frequency of Detection	4/8	2/8
Total Thorium	Range (µg/ℓ)	4.0 - 4.0	NDb
	Mean (µg/ℓ)	2.0	ND
	Frequency of Detection	1/6	ND
U-234	Range (pCi/ℓ)	1.3-5.0	1.600-3.76
	Mean (pCi/ℓ)	3.094	2.131
	Frequency of Detection	7/8	7/8
U-238	Range (pCi/ℓ)	2.0-6.8	2.49-4.50
	Mean (pCi/ℓ)	3.604	3.056
	Frequency of Detection	7/8	7/8
Total Uranium	Range (µg/ℓ)	5.0 - 19.0	7.0 - 15.0
	Mean (µg/ℓ)	11	8
	Frequency of Detection	7/8	7/8

[a]If the distribution is normal or if the distribution is log-normal, the number of detects $\geq$ 7, and frequency of detection $\geq$ 50%, an arithmetic mean is given. If the distribution is log-normal and either the number of detects < 7 or the frequency of detection is < 50%, a geometric mean is given. Details of statistical analyses are described in the Risk Assessment Work Plan Addendum (DOE 1992a).
[b]Not detected.

TABLE 4-32

CHEMICALS AND GENERAL PARAMETERS DETECTED DURING RI/FS SAMPLING OF PADDYS RUN SURFACE WATER

Chemical	Parameters	Between FEMP Northern Property Boundary and the Confluence with the Storm Sewer Outfall Ditch	Downstream of the Confluence with the Storm Sewer Outfall Ditch
Aluminum	Range (mg/ℓ)	0.076-0.451	0.071-0.071
	Mean[a] (mg/ℓ)	0.086	0.051
	Frequency of Detection	3/5	2/4
Ammonia	Range (mg/ℓ)	0.1-0.452	0.163-0.163
	Mean (mg/ℓ)	0.185	0.073
	Frequency of Detection	3/6	1/5
Antimony	Range (mg/ℓ)	0.003-0.003	ND[b]
	Mean (mg/ℓ)	[c]	ND
	Frequency of Detection	1/2	ND
Arsenic	Range (mg/ℓ)	0.019-0.019	0.002-0.003
	Mean (mg/ℓ)	0.002	0.002
	Frequency of Detection	1/6	2/4
Barium	Range (mg/ℓ)	0.029-0.066	0.037-0.047
	Mean (mg/ℓ)	0.046	0.043
	Frequency of Detection	6/6	4/4
Beryllium	Range (mg/ℓ)	0.001-0.001	ND
	Mean (mg/ℓ)	[c]	ND
	Frequency of Detection	2/2	ND
Cadmium	Range (mg/ℓ)	0.003-0.003	0.004-0.005
	Mean (mg/ℓ)	0.003	0.004
	Frequency of Detection	5/6	3/4
Calcium	Range (mg/ℓ)	45.2-87.4	84.7-97.2
	Mean (mg/ℓ)	66.7	91.275
	Frequency of Detection	6/6	4/4
Chloride	Range (mg/ℓ)	9.21-19.99	9.16-19.1
	Mean (mg/ℓ)	13.578	14.702
	Frequency of Detection	6/6	5/5
Chromium	Range (mg/ℓ)	0.014-0.026	0.017-0.02
	Mean (mg/ℓ)	0.018	0.015
	Frequency of Detection	5/6	3/4
Copper	Range (mg/ℓ)	0.010-0.015	0.012-0.012
	Mean (mg/ℓ)	0.007	0.009
	Frequency of Detection	2/6	2/4

TABLE
(Continued)

Chemical	Parameters	Between FEMP Northern Property Boundary and the Confluence with the Storm Sewer Outfall Ditch	Downstream of the Confluence with the Storm Sewer Outfall Ditch
Diethyl Phthalate	Range (mg/ℓ)	0.002-0.002	ND
	Mean (mg/ℓ)	c	ND
	Frequency of Detection	1/2	ND
Fluoride	Range (mg/ℓ)	0.18-0.23	0.21-0.3
	Mean (mg/ℓ)	0.212	0.251
	Frequency of Detection	6/6	5/5
Iron	Range (mg/ℓ)	0.024-0.556	0.015-0.029
	Mean (mg/ℓ)	0.109	0.023
	Frequency of Detection	6/6	4/4
Lead	Range (mg/ℓ)	0.002-0.009	0.003-0.007
	Mean (mg/ℓ)	0.003	0.002
	Frequency of Detection	4/6	2/4
Magnesium	Range (mg/ℓ)	9.97-20.9	20.5-23.6
	Mean (mg/ℓ)	15.745	22.25
	Frequency of Detection	6/6	4/4
Manganese	Range (mg/ℓ)	0.009-0.028	0.008-0.032
	Mean (mg/ℓ)	0.018	0.021
	Frequency of Detection	6/6	4/4
Mercury	Range (mg/ℓ)	0.0003-0.0003	0.0002-0.0002
	Mean (mg/ℓ)	0.00017	0.00012
	Frequency of Detection	2/6	1/4
Molybdenum	Range (mg/ℓ)	0.021-0.021	ND
	Mean (mg/ℓ)	0.008	ND
	Frequency of Detection	1/6	ND
N-Nitrosodiphenylamine	Range (mg/ℓ)	0.004-0.0047	ND
	Mean (mg/ℓ)	c	ND
	Frequency of Detection	1/2	ND
Nickel	Range (mg/ℓ)	0.025-0.025	ND
	Mean (mg/ℓ)	0.013	ND
	Frequency of Detection	1/6	ND
Nitrate	Range (mg/ℓ)	2.12-12.1	2.28-11.3
	Mean (mg/ℓ)	4.27	3.907
	Frequency of Detection	6/6	5/5
Phenols	Range (mg/ℓ)	0.02-0.02	0.02-0.02
	Mean (mg/ℓ)	0.008	0.008
	Frequency of Detection	1/6	1/5

TABLE
(Continued)

Chemical	Parameters	Between FEMP Northern Property Boundary and the Confluence with the Storm Sewer Outfall Ditch	Downstream of the Confluence with the Storm Sewer Outfall Ditch
Phosphorous, (black, white, red)	Range (mg/ℓ)	0.140-0.482	0.032-0.39
	Mean (mg/ℓ)	0.211	0.166
	Frequency of Detection	4/5	5/5
Potassium	Range (mg/ℓ)	1.68-3.19	1.55-2.99
	Mean (mg/ℓ)	2.722	2.235
	Frequency of Detection	6/6	4/4
Selenium	Range (mg/ℓ)	0.017-0.017	ND
	Mean (mg/ℓ)	0.002	ND
	Frequency of Detection	1/6	ND
Silicon	Range (mg/ℓ)	2.25-4.61	1.73-4.65
	Mean (mg/ℓ)	3.777	3.443
	Frequency of Detection	3/3	4/4
Silver	Range (mg/ℓ)	0.012-0.013	0.011-0.019
	Mean (mg/ℓ)	0.006	0.014
	Frequency of Detection	2/6	3/4
Sodium	Range (mg/ℓ)	5.903-10.4	9.88-10.5
	Mean (mg/ℓ)	8.894	10.103
	Frequency of Detection	6/6	4/4
Sulfate	Range (mg/ℓ)	37-57.36	28.57-57.36
	Mean (mg/ℓ)	46.143	43.542
	Frequency of Detection	6/6	5/5
Total Kjeldahl Nitrogen	Range (mg/ℓ)	0.347-1.81	0.347-1.14
	Mean (mg/ℓ)	1.232	[c]
	Frequency of Detection	4/4	2/2
Total Organic Carbon	Range (mg/ℓ)	4.11-5.59	3.741-5.06
	Mean (mg/ℓ)	1.54	4.36
	Frequency of Detection	2/4	4/4
Total Organic Halides	Range (mg/ℓ)	0.01-0.031	ND
	Mean (mg/ℓ)	0.013	ND
	Frequency of Detection	2/4	ND
Total Organic Nitrogen	Range (mg/ℓ)	0.347-1.36	0.2-0.977
	Mean (mg/ℓ)	0.83	0.381
	Frequency of Detection	6/6	5/5
Vanadium	Range (mg/ℓ)	0.011-0.018	ND
	Mean (mg/ℓ)	0.012	ND
	Frequency of Detection	4/5	ND

TABLE
(Continued)

Chemical	Parameters	Between FEMP Northern Property Boundary and the Confluence with the Storm Sewer Outfall Ditch	Downstream of the Confluence with the Storm Sewer Outfall Ditch
Zinc	Range (mg/ℓ)	0.011-0.037	ND
	Mean (mg/ℓ)	c	ND
	Frequency of Detection	2/2	ND
Bis (2-Ethylhexyl) phthalate	Range (mg/ℓ)	0.004-0.004	0.002-0.002
	Mean (mg/ℓ)	c	c
	Frequency of Detection	1/2	1/1

[a]If the distribution is normal or if the distribution is log-normal, the number of detects $\geq$ 7, and the frequency of detection $\geq$ 50%, an arithmetic mean is given. If the distribution is log-normal and either the number of detects < 7 or the frequency of detection is < 50%, a geometric mean is given. Details of statistical analyses are described in the Risk Assessment Work Plan Addendum (DOE 1992a).
[b]Not detected.
[c]Not applicable if sample size is $\leq$ 2.

Sediments

Total uranium in RI/FS samples from the upstream station ranged from 1 to 3 µg/g, while the concentration range for all four sampling locations was 1 to 4 µg/g (Table 4-33). These data are consistent with the low end of the range of uranium concentration in sediments reported from the 1988 FEMP monitoring program. Thorium-230 was detected once, slightly above the analytical detection limit of 0.6 pCi/g. Radium-226 was detected in all samples at levels near the analytical detection limit of 0.5 pCi/g.

Table 4-34 summarizes the chemical data from single sediment samples from the four sampling locations on Paddys Run. Concentrations of inorganics were essentially the same below the FEMP northern boundary as at the upstream background station (W5), with average concentrations within a factor of two of the background value. Six organics were detected at levels below or near the analytical detection limits (Table 4-34).

4.1.3.3 SSOD

NLO (1977 - 1985) and WMCO (1986 - 1991), Environmental Monitoring Annual Reports

Surface Water

Two surface water samples were collected from the SSOD in 1989 as part of the FEMP monitoring program. The uranium concentrations were 2 and 17 pCi/ℓ.

Sediments

Uranium isotopes and technetium-99 were the most abundant radionuclides in SSOD sediments, with average concentrations several times those found in Paddys Run upstream of the SSOD (Tables 4-28, 4-35). This was consistent with the observations that uranium and technetium concentrations in Paddys Run sediments increased downstream of the SSOD. Thorium isotopes were slightly higher in the SSOD and in Paddys Run downstream, but other radionuclides were comparable in samples from the SSOD and both Paddys Run areas (Table 4-28).

"Interim Report - Air, Soil, Water, and Health Risk Assessment in the Vicinity of the FMPC, Fernald, Ohio," IT (1986)

Surface Water

A single surface water sample was collected from the outfall discharge at the storm water retention basin along the uppermost reaches of the SSOD. Total uranium and total thorium were not detected. Technetium-99 concentration was detected at 49.0 pCi/ℓ.

This water sample was also analyzed for a variety of metals, organic compounds, and other general chemical parameters. Most analyzed compounds were not detected, were not present in sufficient

TABLE 4-33

RADIONUCLIDES DETECTED DURING RI/FS SAMPLING OF PADDYS RUN SEDIMENTS

Radionuclide	Parameters	Upstream of the FEMP Northern Property Boundary	Between the FEMP Northern Boundary and the Confluence with the Storm Sewer Outfall Ditch[a]	Downstream of the Confluence with the Storm Sewer Outfall Ditch
Gross Alpha	Range (pCi/g)	7.0-11.0	9.0-34.0	16.0-16.0
	Mean[b] (pCi/g)	[c]	14.875	6
	Detection Frequency	2/2	3/4	1/1
Gross Beta	Range (pCi/g)	11.0-12.0	10.0-13.0	ND[d]
	Mean (pCi/g)	[c]	7.750	ND
	Detection Frequency	2/2	2/4	ND
Radium-226	Range (pCi/g)	0.4-0.5	0.4-1.0	0.4-0.5
	Mean (pCi/g)	0.433	0.7	0.467
	Detection Frequency	3/3	6/6	3/3
Thorium-230	Range (pCi/g)	ND	ND	0.8-0.8
	Mean (pCi/g)	ND	ND	[c]
	Detection Frequency	ND	ND	1/1
Total Uranium	Range (pCi/g)	1.0-3.0	1.0-4.0	1.0-3.0
	Mean (pCi/g)	1.667	1.917	2.0
	Detection Frequency	3/3	5/6	3/3

[a]Combines sampling points W10 and W11.
[b]If the distribution is normal or if the distribution is log-normal, the number of detects $\geq$ 7, and the frequency of detection is $\geq$ 50%, an arithmetic mean is given. If the distribution is log-normal and either the number of detects < 7 or the frequency of detection < 50%, a geometric mean is given. Details of statistical analyses are described in the Risk Assessment Work Plan Addendum (DOE 1992a).
[c]Not applicable if sample size $\leq$ 2.
[d]Not detected.

TABLE 4-34

CHEMICALS DETECTED DURING RI/FS SAMPLING OF PADDYS RUN SEDIMENTS

Chemical	Parameters	Upstream of FEMP Northern Property Boundary	Between the FEMP Northern Boundary and the Confluence with the Storm Sewer Outfall Ditch[a]	Downstream of the Confluence of the Storm Sewer Outfall Ditch
2-Butanone	Range (mg/kg)	ND[b]	ND	0.012-0.012
	Mean[c](mg/kg)	ND	ND	
	Detection Frequency	ND	ND	1/1
2-Hexanone	Range (mg/kg)	ND	ND	0.011-0.011
	Mean (mg/kg)	ND	ND	
	Detection Frequency	ND	ND	1/1
Acetone	Range (mg/kg)	0.018-0.018	0.008-0.008	0.014-0.014
	Mean (mg/kg)			
	Detection Frequency	1/1	1/2	1/1
Aluminum	Range (mg/kg)	1970.0-1970.0	2080.0-2080.0	2480.0-2480.0
	Mean (mg/kg)			
	Detection Frequency	1/1	2/2	1/1
Arsenic	Range (mg/kg)	7.0-7.0	2.7-6.5	2.6-2.6
	Mean (mg/kg)			
	Detection Frequency	1/1	2/2	1/1
Barium	Range (mg/kg)	21.0-21.0	21.0-31.2	21.2-21.2
	Mean (mg/kg)			
	Detection Frequency	1/1	2/2	1/1
Beryllium	Range (mg/kg)	0.5-0.5	0.5-0.5	0.5-0.5
	Mean (mg/kg)			
	Detection Frequency	1/1	2/2	1/1
Cadmium	Range (mg/kg)	3.7-3.7	3.9-4.5	5.5-5.5
	Mean (mg/kg)			
	Detection Frequency	1/1	2/2	1/1
Calcium	Range (mg/kg)	25900-25900	78700-110,000	103000-103000
	Mean (mg/kg)			
	Detection Frequency	1/1	2/2	1/1
Chromium	Range (mg/kg)	18.3-18.3	17.4-18.4	16.9-16.9
	Mean (mg/kg)			
	Detection Frequency	1/1	2/2	1/1
Cobalt	Range (mg/kg)	4.9-4.9	4.7-6.5	5.2-5-2
	Mean (mg/kg)			
	Detection Frequency	1/1	2/2	1/1
Copper	Range (mg/kg)	10.8-10.8	11.7-14.5	11.5-11.5
	Mean (mg/kg)			
	Detection Frequency	1/1	2/2	1/1
Di-n-butyl phthalate	Range (mg/kg)	0.039-0.039	0.051-0.055	ND
	Mean (mg/kg)			ND
	Detection Frequency	1/1	2/2	ND

TABLE 4-34
(Continued)

Chemical	Parameters	Upstream of FEMP Northern Property Boundary	Between the FEMP Northern Boundary and the Confluence with the Storm Sewer Outfall Ditch[a]	Downstream of the Confluence of the Storm Sewer Outfall Ditch
Iron	Range (mg/kg)	6700.0-6700.0	5940.0-8830.0	5600.0-5600.0
	Mean (mg/kg)	[d]	[d]	[d]
	Detection Frequency	1/1	2/2	1/1
Lead	Range (mg/kg)	9.3-9.3	4.6-11.4	4600.0-4600.0
	Mean (mg/kg)	[d]	[d]	[d]
	Detection Frequency	1/1	2/2	1/1
Magnesium	Range (mg/kg)	18700-18700	18300-26600	35900-35900
	Mean (mg/kg)	[d]	[d]	[d]
	Detection Frequency	1/1	2/2	1/1
Manganese	Range (mg/kg)	411.0-411.0	362.0-415.0	273.00-273.00
	Mean (mg/kg)	[d]	[d]	[d]
	Detection Frequency	1/1	2/2	1/1
Methylene chloride	Range (mg/kg)	0.007-0.007	0.015-0.015	0.001-0.001
	Mean (mg/kg)	[d]	[d]	[d]
	Detection Frequency	1/1	1/2	1/1
Nickel	Range (mg/kg)	13.7-13.7	16.4-19.5	17.9-17.9
	Mean (mg/kg)	[d]	[d]	[d]
	Detection Frequency	1/1	2/2	1/1
Potassium	Range (mg/kg)	307.0-307.0	366.0-655.0	421.0-421.0
	Mean (mg/kg)	[d]	[d]	[d]
	Detection Frequency	1/1	2/2	1/1
Sodium	Range (mg/kg)	197.0-197.0	180.0-188.0	188.0-188.0
	Mean (mg/kg)	[d]	[d]	[d]
	Detection Frequency	1/1	2/2	1/1
Vanadium	Range (mg/kg)	12.4-12.4	13.7-14.0	15.4-15.4
	Mean (mg/kg)	[d]	[d]	[d]
	Detection Frequency	1/1	2/2	1/1
Zinc	Range (mg/kg)	13.5-13.5	13.4-24.4	15.3-15.3
	Mean (mg/kg)	[d]	[d]	[d]
	Detection Frequency	1/1	2/2	1/1
bis(2-Ethylhexyl)phthalate	Range (mg/kg)	0.46-0.46	0.5-0.59	0.4-0.4
	Mean (mg/kg)	[d]	[d]	[d]
	Detection Frequency	1/1	2/2	1/1

[a]Combines sampling points W10 and W11.
[b]Not detected.
[c]If the distribution is normal or if the distribution is log-normal, the number of detects $\geq$ 7, and frequency of detection $\geq$ 50%, an arithmetic mean is given. If the distribution is log-normal and either the number of detects < 7 or the frequency of detection is < 50%, a geometric mean is given. Details of statistical analyses are described in the Risk Assessment Work Plan Addendum (DOE 1992a).
[d]Not applicable if sample size is $\leq$ 2.

TABLE 4-35

TECHNETIUM-99 IN FEMP ON-PROPERTY SEDIMENT[a] ENVIRONMENTAL MONITORING ANNUAL REPORTS, 1983-1984

Sampling Location	Year	Concentration (pCi/g)[b]	95% Confidence Level[c]
Upstream - Paddy's Run			
1	1983	<0.14	±20%
1	1984	0.70	±0.2
Storm Sewer Outfall Ditch			
5	1983	1.4	±20%
7	1984	4.3	±0.2
6	1983	17.0	20%
11	1984	16.0	0.6
Paddy's Run - Downstream of the Storm Sewer Outfall Ditch			
4	1983	8.1	20%
6	1984	30.0	0.2

[a]Samples consisted of a composite of May and August material.

[b](pCi/g) = picocuries per gram.

[c]Confidence level for 1984 data = 2σ

concentrations to constitute a detection, or were also present in the sample blank. The pesticide endosulfan sulfate was present at a level just above the detection limit (0.00012 mg/ℓ).

Sediment

One sediment sample was collected from the SSOD near the confluence with Paddys Run. This sample contained the highest levels of total uranium (5.90 pCi/g) and total thorium (3.08 pCi/g) for the sediments collected during this effort.

RI/FS Sampling and Analysis

Surface Water

Since the SSOD carries only storm water runoff, surface water samples could only be collected after major storm events. Total uranium concentrations in samples from Stations ASIT-001 and ASIT-002 (Figure 3-10) were 18 and 24 µg/ℓ, respectively. Total uranium concentrations at Station ASIT-003 ranged from 2 to 7 µg/ℓ, and were lower than those from upstream. This may be due to dilution by runoff from a drainage which enters the SSOD approximately 100 feet downgradient from Station ASIT-002. One surface water sample each from ASIT-002 and ASIT-003 were analyzed for general chemical parameters and metals. No above background levels of inorganic chemicals were detected.

Sediment

The total uranium levels measured in samples from Stations ASIT-001, ASIT-002, and ASIT-003 were 4 µg/g, 12 µg/g, and 9 µg/g, respectively. The corresponding total activity concentrations based on the sum of uranium isotopic concentrations were 2.7, 9.3, and 5.5 pCi/g. These results are generally consistent with the average uranium concentration of 10.5 pCi/g observed in the 1988 FEMP monitoring program. Thorium-230 concentrations of 2.5, 1.9, and 2.6 pCi/g were also observed in samples collected from stations ASIT-001, ASIT-002, and ASIT-003, respectively. Radium-226 was observed at ASIT-003 at 0.7 pCi/g, just above the analytical detection level.

4.1.3.4 Waste Pit Area Surface Water Drainage Ditches

FEMP Environmental Monitoring Results

Surface Water

Several surface water samples were collected from drainage ditches that carried water from the waste pit area (WMCO 1989). These samples had uranium concentrations below the DOE standard guideline (550 pCi/ℓ for off-site discharges) but above background, and may have contributed to uranium in Paddys Run (Table 4-36).

"FMPC Sampling and Analysis Report," DOE (1988)

Surface Water

One of the primary purposes of this study was to characterize potential source areas such as the waste pit area. Samples were collected from Waste Pit 5, Waste Pit 6, the Clearwell, and Manhole-175.

TABLE 4-36

ANALYTICAL RESULTS FOR DRAINAGE DITCH SAMPLES COLLECTED AT THE FEMP JULY 20 AND JULY 21, 1988

Analyte	Units	DD-01 7-20-88	DD-07 7-21-88	DD-08 7-21-88	DD-09 7-21-88
Aluminum	µg/ℓ	869	456	1470	964
Barium	µg/ℓ	217	320	200u	209
Calcium	µg/ℓ	153,000	157,000	31,400	80,100
Chromium	µg/ℓ	10.0u	10.0u	10.0u	10.0u
Copper	µg/ℓ	25.0u	28.8	25.0u	25.0u
Iron	µg/ℓ	1080	601	1730	889
Lead	µg/ℓ	5.0u	5.0u	17.3	5.0u
Magnesium	µg/ℓ	31,500	38,300	7230	19,200
Manganese	µg/ℓ	143	494	494	96.2
Sodium	µg/ℓ	10,100	16,800	5980	25,300
Zinc	µg/ℓ	84.4	20.0u	426	26.0
TOC	mg/ℓ	14.4	118	10.1	7.6
TOX	µg/ℓ	41	260	64	37
TDS	mg/ℓ	692	1190	87.0	414
TSS	mg/ℓ	266	20.0	472	148
Oil and Grease	mg/ℓ	1.0u	1.0u	1.4	1.8
Chloride	mg/ℓ	11.3	28.1	14.8	39.3
Fluoride	mg/ℓ	0.24	1.2	0.10u	1.3
Sulfate	mg/ℓ	317	38.3	6.8	89.9
Nitrate	mg/ℓ	1.0u	0.20u	1.0u	2.6
1,1,1-TCA	µg/ℓ	NR	NR	NR	NR
TCE	µg/ℓ	NR	NR	NR	NR
PERC	µg/ℓ	NR	NR	NR	NR

See footnotes at end of table.

TABLE 4-36
(Continued)

Analyte	Units	DD-01 7-20-88	DD-07 7-21-88	DD-08 7-21-88	DD-09 7-21-88
Gross Alpha	pCi/ℓ	8±5	850±50	49±9	420±30
Gross Beta	pCi/ℓ	13±3	560±20	39±4	380±10
Thorium-228	pCi/ℓ	NR	NR	NR	0.1±0.3
Thorium-230	pCi/ℓ	NR	NR	NR	1.4±0.5
Thorium-232	pCi/ℓ	NR	NR	NR	0.1±0.2
Uranium-234	pCi/ℓ	0.6±0.5	160±30	7.0±0.6	57±30
Uranium-235	pCi/ℓ	0.3±0.2	5±10	0.3±0.1	1.0±8.6
Uranium-238	pCi/ℓ	2.4±0.5	740±60	9.4±0.7	310±40
Radium-226	pCi/ℓ	NR	NR	1.4±0.4	NR
Radium-228	pCi/ℓ	NR	NR	3.1±2.2	NR
Flow	gpm	p	1	p	30
pH	std.	7.6	7.5	7.7	7.9
Conductivity	µmhos	700	900	7.5	420
Temperature	°C	25	22	25	20

See footnotes at end of table.

TABLE 4-36
(Continued)

Analyte	Units	DD-12 7-20-88	DD-13 7-20-88	DD-14 7-20-88	DD-17 7-20-88
Aluminum	µg/ℓ	345	200u	14,400	47,000
Barium	µg/ℓ	200u	200u	387	366
Calcium	µg/ℓ	33,700	5000u	255,000	372,000
Chromium	µg/ℓ	10.0u	10.0u	12.8	66.3
Copper	µg/ℓ	25.0u	25.0u	50.4	106
Iron	µg/ℓ	382	100u	19,300	95,600
Lead	µg/ℓ	5.0u	5.0	38.2	34.5
Magnesium	µg/ℓ	5000	5000u	43,600	93,000
Manganese	µg/ℓ	19.0	15.0u	2080	2270
Sodium	µg/ℓ	26,100	5000u	10,400	5000u
Zinc	µg/ℓ	53.3	20.0u	136	331
TOC	mg/ℓ	10.1	5.0	16.6	13.2
TOX	µg/ℓ	14	10u	39	22
TDS	mg/ℓ	237	169	358	370
TSS	mg/ℓ	10.0	23.0	2150	7670
Oil and Grease	mg/ℓ	1.0u	1.6	1.0u	1.2
Chloride	mg/ℓ	14.8	5.7	227	2.5u
Fluoride	mg/ℓ	1.5	0.69	0.68	0.31
Sulfate	mg/ℓ	48.1	25.7	48.4	121
Nitrate	mg/ℓ	6.3	3.1	1.8	6.4
1,1,1-TCA	µg/ℓ	NR	NR	NR	NR
TCE	µg/ℓ	NR	NR	NR	NR
PERC	µg/ℓ	NR	NR	NR	NR

See footnotes at end of table.

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TABLE 4-36
(Continued)

Analyte	Units	DD-12 7-20-88	DD-13 7-20-88	DD-14 7-20-88	DD-17 7-20-88
Gross Alpha	pCi/ℓ	390±20	180±100	450±60	120±50
Gross Beta	pCi/ℓ	330±10	140±10	370±30	270±40
Thorium-228	pCi/ℓ	NR	NR	NR	NR
Thorium-230	pCi/ℓ	NR	NR	NR	NR
Thorium-232	pCi/ℓ	NR	NR	NR	NR
Uranium-234	pCi/ℓ	150±20	45±11	120±10	42±4
Uranium-235	pCi/ℓ	8.7±4.4	6.1±3.7	21±5	2.6±1.2
Uranium-238	pCi/ℓ	230±20	100±14	220±20	42±4
Radium-226	pCi/ℓ	NR	NR	7.0±0.6	11±1
Radium-228	pCi/ℓ	NR	NR	4.5±1.8	5.3±1.7
Flow	gpm	P	2	10	6
pH	std.	6.3	5.7	7.9	8.1
Conductivity	µmhos	280	210	238	300
Temperature	°C	25	29	23	25

See footnotes at end of table.

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TABLE 4-36
(Continued)

Analyte	Units	DD-19 7-20-88	DD-21 7-20-88	DD-23 7-20-88	DD-ALT3 7-20-88
Aluminum	µg/ℓ	15,200	200u	11,700	404
Barium	µg/ℓ	300	200u	226	200u
Calcium	µg/ℓ	47,900	5000u	85,900	70,700
Chromium	µg/ℓ	19.1	10.0u	18.5	10.0u
Copper	µg/ℓ	57.5	25.0u	37.8	25.0u
Iron	µg/ℓ	17,900	170	22,200	369
Lead	µg/ℓ	44.5	5.0	14.0	5.0u
Magnesium	µg/ℓ	9860	5000u	18,400	15,300
Manganese	µg/ℓ	725	20.0	713	102
Sodium	µg/ℓ	5000u	5000u	5000u	15,500
Zinc	µg/ℓ	107	20.0u	106	108
TOC	mg/ℓ	4.5	2.8	9.4	5.6
TOX	µg/ℓ	28	35	43	10u
TDS	mg/ℓ	156	42.0	155	370
TSS	mg/ℓ	405	21.0	385	11.0
Oil and Grease	mg/ℓ	1.0u	1.1	1.0u	1.0u
Chloride	mg/ℓ	2.5u	2.5	2.5u	12.6
Fluoride	mg/ℓ	0.26	0.10u	0.32	1.3
Sulfate	mg/ℓ	25.5	6.2	14.3	102
Nitrate	mg/ℓ	1.4	6.1	0.20u	0.10u
1,1,1-TCA	µg/ℓ	NR	NR	NR	NR
TCE	µg/ℓ	NR	NR	NR	NR
PERC	µg/ℓ	NR	NR	NR	NR

See footnotes at end of table.

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TABLE 4-36
(Continued)

Analyte	Units	DD-19 7-20-88	DD-21 7-20-88	DD-23 7-20-88	DD-ALT3 7-20-88
Gross Alpha	pCi/ℓ	290±90	3±1	100±20	520±40
Gross Beta	pCi/ℓ	260±60	4±2	110±10	190±20
Thorium-228	pCi/ℓ	NR	NR	NR	NR
Thorium-230	pCi/ℓ	NR	NR	NR	NR
Thorium-232	pCi/ℓ	NR	NR	NR	NR
Uranium-234	pCi/ℓ	69±9	0.6±0.2	14±4	270±30
Uranium-235	pCi/ℓ	7.4±3.0	0.1±0.1	2.0±1.3	12±8
Uranium-238	pCi/ℓ	100±10	1.0±0.3	64±6	310±30
Radium-226	pCi/ℓ	14±1	NR	3.1±0.5	NR
Radium-228	pCi/ℓ	7.8±2.7	NR	2.1±1.7	NR
Flow	gpm	10	40	30	p
pH	std.	8.8	7.3	7.9	7.8
Conductivity	µmhos	120	38	132	490
Temperature	°C	25	25	25	26

A "u" indicates the parameter was analyzed for but not detected. The minimum detection limit for the sample, not the method detection limit, is reported preceding the "u".
A "j" indicates the parameter was detected, but was not quantifiable. The detection limit for the sample is reported preceding the "j".
NR = Not requested.
TOC = total organic carbon.
TOX = total organic halogen.
TDS = total dissolved solids.
TSS = total suspended solids.
1,1,1-TCA = 1,1,1-trichloroethane.
TCE = trichloroethylene.
PERC = perchloroethylene (or tetrachloroethylene).
P = ponded water (not measurably flowing).

See footnotes at end of table.

Radioactivity in the Pit 5 and Pit 6 samples was above background levels (Table 4-37). pH and temperature in Pit 5 varied widely between the influent and effluent areas.

Barium was observed in most samples, with a peak concentration of 2.99 mg/ℓ in the Pit 5 influent sample (0716) (Table 4-37). This sample also contained detectable chromium and lead. One sample each from Pit 6 and the Clearwell contained lead and mercury. Three organics were detected: acetone, chloroform, and methylene chloride.

Although the number of samples analyzed for radionuclides was limited, the Clearwell samples had detectable neptunium, total uranium, and thorium isotopes (particularly thorium-230). Uranium-235 was detected in one sample each from Pit 5 and Pit 6. These samples also contained total uranium. Detectable asbestos was present in one Pit 5 sample. However, higher concentrations (up to 8.19 mean fibers per liter) were observed in the Pit 6 samples.

Sediment

Sediment sampling in the waste pit area was limited to one sample each from Pit 5, Pit 6, and the Clearwell. Similar to the water samples from these locations, sediment samples also had detectable acetone and chloroform in one or more samples (Table 4-38). Peak organic concentrations were observed in Pit 5, which also had xylene (24 µg/kg) and 1,1,1-trichloroethane (29 µg/kg). While the Pit 5 sample had detectable concentrations of uranium-235, uranium-238, bismuth-214, radium-226, thorium-228, thorium-232, and total uranium, the sample from Pit 6 had higher concentrations of uranium-235 (71 pCi/g) and uranium-238 (16,650 pCi/g). The Clearwell had the highest levels of cesium-137 (58 pCi/g) and total uranium (32,100 mg/kg) (Table 4-38).

"Feed Materials Production Center, Characterization Investigation Study," Weston (1987b)

Surface Water

Water samples were collected from Pits 4, 5, 6, and the Clearwell, but Pit 4 is now completely covered with an interim cap. Uranium and technetium were the radionuclides present in the highest concentrations (Table 4-39). Thorium-230, cesium-137, strontium-90, and radium-226 and -228 were also detected.

The samples collected from the Waste Pits and the Clearwell were also analyzed for chemical constituents. Calcium, magnesium, sodium, and potassium were abundant, and a number of other inorganic and organic chemicals were detected in at least one sample (Table 4-40).

TABLE 4-37

SURFACE WATER FIELD PARAMETERS AND ANALYTE CONCENTRATIONS ABOVE MINIMUM DETECTION LEVELS FOR SAMPLES COLLECTED IN THE WASTE PIT AREA

	Manhole-175	Clearwell		Pit 5		Pit 6	
Sample ID Parameter	0403	0713	0714	0715	0716	0717	0718
Radioactivity (μR/hr)	10	---[a]	---	100-300	Bkgd[b]	100-300	100-300
pH	7.4	---	---	8.5	11.0	6.5	6.0
Temperature	23.5	---	---	24.0	38.5	26.0	25.5
Conductance (mS)	1.15	---	---	---	---	---	---
Organics (μg/ℓ):							
Acetone	NS[c]	---	---	---	830 (1100B)[d]	34 (16B)	---
Chloroform	NS	---	---	25M[e]	6 (8B)	---	---
Methylene Chloride	NS	5300MV[f]	11M	---	9B (7B)	(22B)	9B
Radionuclides (pCi/ℓ):							
Neptunium-237	NS	0.03	---	NS	NS	NS	NS
Thorium-228	---	0.58	0.43	---	---	---	---
Thorium-230	NS	3.34	3.49	NS	NS	NS	NS
Thorium-232	---	0.23	0.2	---	---	---	---
Uranium-235	---	---	---	---	558	112	---
Total Uranium (μg/ℓ)	NS	3000M	2600M	832M	33100M	25400M	27200M

See footnotes at end of table.

TABLE 4-37
(Continued)

Sample ID Parameter	Manhole-175 0403	Clearwell 0713	 0714	Pit 5 0715	 0716	Pit 6 0717	 0718
RCRA Metals (mg/ℓ):							
Barium	0.16	0.22M	0.14M	0.07M	2.99	0.15M	0.08M
Chromium	---	---	---	---	0.07M	---	---
Mercury	NS	0.001M	---	---	---	---	---
Lead	---	---	---	---	0.57M	0.37M	---

[a]For radioactivity, pH, temperature, and conductance indicates not applicable. For organics and radionuclides indicates sample concentration below MDL.

[b]Background levels.

[c]NS = Sample not analyzed for indicated analyte.

[d]B = Analyte found in blank as well as sample. Concentration of analyte in blank given in parentheses.

[e]M = Greatest value from multiple analyses of sample.

[f]V = Value from multiple analyses with high variability.

Source: Department of Energy, 1988. "Feed Materials Production Center, Sampling and Analysis Document."

TABLE 4-38

ANALYTE CONCENTRATIONS
ABOVE MINIMUM DETECTION LEVELS FOR SEDIMENT SAMPLES COLLECTED IN THE WASTE PIT AREA

Parameter	Sample ID	Clearwell 0721	Pit 5 0719	Pit 6 0720
Organics gR/kg):				
Acetone		19B[b]	440	—[b]
Chloroform		8	140	7
Xylene		—	24	—
1,1,1-Trichloroethane		—	29	—
Toluene		—	—	5B
Radionuclides (pCi/g):				
Bismuth-214		7.9	24	—
Cesium-137		58	1.6	26
Uranium-235		1.7	33	71
Uranium-238		176	2046	16,650
Radium-226		8	25	1.6
Thorium-228		8.3	36	5.6
Thorium-232		8.1	24	1.7
Total U (mg/kg)		32,100	306	4270

[a]B = Analyte found in blank as well as sample.
[b]For organics and radionuclides indicates sample concentration below MDL.

Source: Department of Energy, 1988. "Feed Materials Production Center, Sampling and Analysis Document."

TABLE 4-39

RADIONUCLIDES DETECTED DURING CIS SAMPLING OF WASTE PIT 5, WASTE PIT 6, AND CLEARWELL

Radionuclide	Parameter	Waste Pit 5	Waste Pit 6	Clearwell
Cesium-137	Range (pCi/ℓ)	51-90	ND	ND
	Mean[a] (pCi/ℓ)	[b]	ND	ND
	Frequency of Detection	2/2	ND	ND
Radium-226	Range (pCi/ℓ)	ND[c]	ND	1.1-1.1
	Mean[a] (pCi/ℓ)	ND	ND	[b]
	Frequency of Detection	ND	ND	2/2
Radium-228	Range (pCi/ℓ)	ND	4-13	11-12
	Mean[a] (pCi/ℓ)	ND	7.5	[b]
	Frequency of Detection	ND	4/4	2/2
Strontium-90	Range (pCi/ℓ)	41-47	ND	ND
	Mean[a] (pCi/ℓ)	[b]	ND	ND
	Frequency of Detection	2/2	ND	ND
Technetium-99	Range (pCi/ℓ)	24-320	420-600	2000-4000
	Mean[a] (pCi/ℓ)	[b]	535	[b]
	Frequency of Detection	2/2	4/4	2/2
Thorium-230	Range (pCi/ℓ)	0.1-0.1	0.1-0.3	0.4-0.4
	Mean[a] (pCi/ℓ)	[b]	0.175	[b]
	Frequency of Detection	2/2	4/4	1/2
Uranium-234	Range (pCi/ℓ)	410-420	22-77	1800-1900
	Mean[a] (pCi/ℓ)	[b]	59	[b]
	Frequency of Detection	2/2	4/4	2/2
Uranium-235	Range (pCi/ℓ)	18-19	1.5-9	110-120
	Mean[a]a (pCi/ℓ)	[b]	5.875	[b]
	Frequency of Detection	2/2	4/4	2/2
Uranium-238	Range (pCi/ℓ)	370-400	120-460	5400-6200
	Mean[a] (pCi/ℓ)	[b]	297	[b]
	Frequency of Detection	2/2	4/4	2/2

[a]If the distribution is normal or if the distribution is log-normal, the number of detects ≥ 7, and frequency of detection ≥ 50%, an arithmetic mean is given. If the distribution is log-normal and either the number of detects < 7 or the frequency of detection is < 50%, a geometric mean is given. Details of statistical analyses are described in the Risk Assessment Work Plan Addendum (DOE 1992a).
[b]Not applicable if sample size is ≤2.
[c]Not detected.

TABLE 4-40

CHEMICALS DETECTED DURING CIS SAMPLING
OF WASTE PIT 5, WASTE PIT 6, AND CLEARWELL

Chemical	Parameters	Waste Pit 5	Waste Pit 6	Clearwell
2-nitrophenol	Range (mg/ℓ)	ND[b]	ND	0.004-0.004
	Mean[a] (mg/ℓ)	ND	ND	[c]
	Frequency of Detection	ND	ND	1/1
Acetone	Range (mg/ℓ)	0.007-0.009	0.003-0.003	0.005-0.005
	Mean (mg/ℓ)	[c]	[c]	[c]
	Frequency of Detection	2/2	1/1	1/1
Aluminum	Range (mg/ℓ)	ND	0.283-0.492	ND
	Mean (mg/ℓ)	ND	0.420	ND
	Frequency of Detection	ND	4/4	ND
Benzene	Range (mg/ℓ)	0.011-0.011	ND	ND
	Mean (mg/ℓ)	[c]	ND	ND
	Frequency of Detection	1/1	ND	ND
Bicarbonate	Range (mg/ℓ)	20-52	ND	ND
	Mean (mg/ℓ)	[c]	ND	ND
	Frequency of Detection	2/2	ND	ND
Bis (2-ethylhexyl) phthalate	Range (mg/ℓ)	ND	0.004-0.010	0.004-0.004
	Mean (mg/ℓ)	ND	[c]	[c]
	Frequency of Detection	ND	2/2	1/1
Calcium	Range (mg/ℓ)	177.71-183.83	62.810-111.07	84.810-536.35
	Mean (mg/ℓ)	[c]	95.146	[c]
	Frequency of Detection	2/2	5/5	2/2
Carbonate	Range (mg/ℓ)	40.0-40.0	ND	ND
	Mean (mg/ℓ)	[c]	ND	ND
	Frequency of Detection	2/2	ND	ND

TABLE 4-40
(Continued)

Chemical	Parameters	Waste Pit 5	Waste Pit 6	Clearwell
Chloride	Range (mg/ℓ)	244.34-244.34	149.19-207.63	164.47-195.65
	Mean (mg/ℓ)	c	166.58	c
	Frequency of Detection	2/2	5/5	2/2
Chlorobenzene	Range (mg/ℓ)	ND	0.006-0.006	ND
	Mean (mg/ℓ)	ND	c	ND
	Frequency of Detection	ND	1/1	ND
Chloroform	Range (mg/ℓ)	ND	0.002-0.003	0.007-0.007
	Mean (mg/ℓ)	ND	0.002	c
	Frequency of Detection	ND	4/4	1/1
Copper	Range (mg/ℓ)	ND	ND	0.030-0.030
	Mean (mg/ℓ)	ND	ND	c
	Frequency of Detection	ND	ND	1/1
Cyanide	Range (mg/ℓ)	0.067-0.087	ND	0.087-0.087
	Mean (mg/ℓ)	c	ND	c
	Frequency of Detection	2/2	ND	1/1
Di-n-butyl phthalate	Range (mg/ℓ)	0.001-0.001	0.001-0.006	0.001-0.001
	Mean (mg/ℓ)	c	c	c
	Frequency of Detection	2/2	2/2	1/1
Fluoride	Range (mg/ℓ)	10.120-10.120	10.620-10.620	4.930-6.170
	Mean (mg/ℓ)	c	c	c
	Frequency of Detection	1/1	1/1	2/2
Iron	Range (mg/ℓ)	ND	ND	0.130-0.295
	Mean (mg/ℓ)	ND	ND	c
	Frequency of Detection	ND	ND	2/2
Magnesium	Range (mg/ℓ)	386.04-387.36	0.664-5.483	95.090-150.12
	Mean (mg/ℓ)	c	1.673	c
	Frequency of Detection	2/2	5/5	2/2

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TABLE 4-40
(Continued)

Chemical	Parameters	Waste Pit 5	Waste Pit 6	Clearwell
Manganese	Range (mg/ℓ)	ND	ND	0.031-0.031
	Mean (mg/ℓ)	ND	ND	[c]
	Frequency of Detection	ND	ND	1/1
Mercury	Range (mg/ℓ)	ND	0.00025-0.00025	0.00031-0.00072
	Mean (mg/ℓ)	ND	[c]	[c]
	Frequency of Detection	ND	1/1	2/2
Methylene chloride	Range (mg/ℓ)	0.001-0.002	0.002-0.004	0.002-0.002
	Mean (mg/ℓ)	[c]	0.003	[c]
	Frequency of Detection	2/2	4/4	2/2
Nitrate	Range (mg/ℓ)	ND	29.520-29.520	ND
	Mean (mg/ℓ)	ND	[c]	ND
	Frequency of Detection	ND	1/1	ND
Nitrate/Nitrite	Range (mg/ℓ)	1160.8-1394.9	10.550-20.290	219.52-265.59
	Mean (mg/ℓ)	[c]	17.090	[c]
	Frequency of Detection	2/2	4/4	2/2
Phosphate	Range (mg/ℓ)	0.330-0.330	0.020-0.020	0.230-0.350
	Mean (mg/ℓ)	[c]	0.020	[c]
	Frequency of Detection	2/2	3/3	2/2
Potassium	Range (mg/ℓ)	48.0-92.0	26.0-42.0	30.0-50.0
	Mean (mg/ℓ)	[c]	36.8	[c]
	Frequency of Detection	2/2	5/5	2/2
Silver	Range (mg/ℓ)	ND	ND	0.016-0.016
	Mean (mg/ℓ)	ND	ND	[c]
	Frequency of Detection	ND	ND	1/1
Sodium	Range (mg/ℓ)	1150.0-1320.0	90.000-114.00	232-512
	Mean (mg/ℓ)	[c]	96.0	[c]
	Frequency of Detection	2/2	5/5	2/2

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TABLE 4-40
(Continued)

Chemical	Parameters	Waste Pit 5	Waste Pit 6	Clearwell
Sulfate	Range (mg/ℓ)	100.32-102.11	54.520-79.470	125.00-133.60
	Mean (mg/ℓ)	100.92	61.650	[c]
	Frequency of Detection	3/3	7/7	2/2
Tetrachloroethane	Range (mg/ℓ)	ND	0.001-0.002	ND
	Mean (mg/ℓ)	ND	0.002	ND
	Frequency of Detection	ND	7/7	ND
Toluene	Range (mg/ℓ)	0.001-0.001	0.001-0.002	ND
	Mean (mg/ℓ)	[c]	0.001	ND
	Frequency of Detection	1/1	5/5	ND
Zinc	Range (mg/ℓ)	0.094-0.094	ND	ND
	Mean (mg/ℓ)	[c]	ND	ND
	Frequency of Detection	1/1	ND	ND
Zinc soluble	Range (mg/ℓ)	ND	0.114-0.114	ND
	Mean (mg/ℓ)	ND	[c]	ND
	Frequency of Detection	ND	1/1	ND

[a]If the distribution is normal or if the distribution is log-normal, the number of detects $\geq$ 7, and frequency of detection $\geq$ 50%, an arithmetic mean is given. If the distribution is log-normal and either the number of detects < 7 or the frequency of detection is < 50%, a geometric mean is given. Details of statistical analyses are described in the Risk Assessment Work Plan Addendum (DOE 1992a).
[b]Not detected.
[c]Not applicable if sample size is $\leq$ 2.

RI/FS Sampling and Analysis

Surface Water

Total uranium concentrations in waste pit area drainage ditch surface water ranged from 54 to 9,318 µg/ℓ. Uranium-234 was measured at 597 and 653 pCi/ℓ at locations ASIT-031 and ASIT-030, respectively. Uranium-238 was measured at 2,840 and 2,506 pCi/ℓ in two water samples.

The RI/FS sampling in the waste pit area was limited to a single sampling at several locations. The radionuclides detected were generally limited to uranium isotopes, with total uranium concentrations ranging from 8 µg/ℓ to 9,318 µg/ℓ. Uranium-238 was the most concentrated isotope, with peak concentrations greater than 2,500 pCi/ℓ. The highest concentrations of uranium-234 were 653.0 pCi/ℓ and 597.0 pCi/ℓ and the highest uranium-235/236 values were 51.5 pCi/ℓ and 38.3 pCi/ℓ.

Gross alpha and gross beta were measured in three samples (ASIT-029, ASIT-036, and ASIT-038). Gross alpha ranged from 16 pCi/ℓ (ASIT-036) to 1,300 pCi/ℓ (ASIT-038). Gross beta ranged from 11 pCi/ℓ (ASIT-036) to 1,100 pCi/ℓ (ASIT-038). Other radionuclides detected in the waste pit area included radium-226 at ASIT-028 (1.1 pCi/ℓ), ASIT-029 (3.4 pCi/ℓ), and ASIT-040 (1.1 pCi/ℓ) and radium-228 at ASIT-028 (10.9 pCi/ℓ) and ASIT-029 (4.2 pCi/ℓ). Technetium-99 in three samples ranged from 83.8 pCi/ℓ to 206 pCi/ℓ, with the highest concentrations observed for samples collected at ASIT-030 and ASIT-031.

Most detected chemical constituents in these samples were inorganic metals and compounds at concentrations of less than 1.0 mg/ℓ. Certain detected analytes, such as chloride and calcium, are commonly observed in surface water bodies. Most organic compounds were not detected, but compounds such as bis(2-ethylhexyl) phthalate and di-n-butyl phthalate were observed at levels less than the CRQL.

Sediment

A range of 46 to 728 pCi/g uranium was detected in sediment near Pit 5 and from 96 to 746 pCi/g in sediment from a small drainage ditch east of Pit 4.

4.1.3.5 Production Area Surface Water Drainage Ditches

"Addendum To Best Management Practices Plan: Storm Water Sampling Program Results," Weston (1988)

During 1988, stormwater discharge from the production area was monitored as part of the FEMP Best Management Practices Plan (BMP). Surface water samples collected from sampling locations (DD12 and DD13) on the western perimeter of the production area contained detectable uranium (Figure 3-15). These levels were consistent with concentrations in surface water samples from other ditches that drain the waste pit area. However, only background levels of uranium isotopes (≤1.0 pCi/ℓ) were

detected in the surface water sample collected from DD21, immediately south of the production area parking lot (Table 4-36).

MH-26 had the highest concentrations of uranium-238, with a base flow concentration of 1,700 pCi/ℓ and a storm flow concentration of 920 pCi/ℓ. Peak values for gross alpha (5,400 pCi/ℓ) and gross beta (2,000 pCi/ℓ) were also observed at this location during base flow. Nine other storm sewer samples exceeded the DOE guideline of 600 pCi/ℓ for uranium-238, ranging from 1,300 pCi/ℓ (MH-12 and MH-18) to 630 pCi/ℓ (MH-20).

TDS in the base flow sample from MH-26 was 1190 mg/ℓ, exceeding the Ohio EPA ORC limits of 500 mg/ℓ (monthly average) and 700 mg/ℓ (transient). This sample had the highest levels of inorganics and the highest conductivity. Nitrates and oil and grease were detected at levels higher than those in the other samples, but well below applicable limits.

Higher than average values for specific analytes were also observed in the sample collected at MH-33. During the base flow sampling, this location posted the peak levels for chromium (205 ug/ℓ), zinc (206 ug/ℓ), and fluoride (2.8 mg/ℓ). Similar to MH-33, the MH-22 storm flow fluoride concentration (1.4 mg/ℓ) was lower than the base flow (3.2 mg/ℓ), but the actual amount of fluoride carried in the storm sewers was probably much greater due to the higher flow. The storm flow sample collected from MH-33 also displayed the highest total organic halogens (900 mg/ℓ). The only detectable volatile organic compound was observed at a very low concentration (1,1,1-trichloroethane, 4.6 µg/ℓ).

RI/FS Sampling and Analysis

The RI/FS sampling in the production area was limited to a single round of sampling of surface water at several locations. These sample locations include ASIT-011, ASIT-012, ASIT-013, ASIT-014, ASIT-015, ASIT-016, and ASIT-017. Radionuclides detected in surface water were generally limited to uranium isotopes, with total uranium concentrations ranging from 112 µg/ℓ for ASIT-013 to 1,449 µg/ℓ and 1,464 µg/ℓ for ASIT-015 and ASIT-016, respectively. Only a few other radionuclides were detected in the production area samples. Radium-226 and radium-228 were detected at ASIT-016 at 16.3 pCi/ℓ and 127 pCi/ℓ, respectively. Technetium-99 was detected at ASIT-014 and ASIT-015 at 44.9 pCi/ℓ and 75.4 pCi/ℓ, respectively.

4.1.3.6 Other FEMP Waste Disposal Area Surface Drainages

RI/FS Sampling and Analysis

The sampling of surface water and sediment along surface drainages not included in the sampling efforts for the Great Miami River, Paddys Run, and the SSOD has focused on characterizing the environmental conditions in the immediate vicinity of waste management areas. These areas are similar to the waste pit area (Section 4.1.3.4) and the production area (Section 4.1.3.5). The Sanitary

Landfill contains RI/FS monitoring location ASIT-021. However, this area is adjacent to the waste pit area and is included in the description of the data for that locality (Section 4.1.3.4).

The active fly ash disposal area is monitored at RI/FS sampling locations ASIT-004, ASIT-005, ASIT-006, and ASIT-007. The inactive fly ash disposal area has two RI/FS sampling locations, ASIT-008 and ASIT-009. The area near Silos 1 and 2 is monitored at several sample locations (ASIT-010, ASIT-023, ASIT-024, ASIT-025, and ASIT-026) (Figure 3-17).

Surface Water

RI/FS sampling adjacent to the active fly ash disposal area has been limited to a single sample at several locations (ASIT-004, ASIT-005, ASIT-006, and ASIT-007). Samples were analyzed for total uranium, with concentrations of 1,692 (ASIT-004), 499 (ASIT-005), 14 (ASIT-006), and 24 µg/ℓ (ASIT-007). The only other detected radionuclide was a 1.5 pCi/ℓ concentration of radium-226 in a sample collected at ASIT-005. A sample collected from the inactive fly ash disposal area at ASIT-009 had a total uranium concentration of 40.0 µg/ℓ. Inorganics detected in this sample included barium (0.0267 mg/ℓ), cadmium (0.0016 mg/ℓ), mercury (0.008 mg/ℓ), and magnesium (10.1 mg/ℓ). Sulfate and potassium were also detected at 171.0 mg/ℓ and 2.33 mg/ℓ, respectively.

Samples from ASIT-023 and ASIT-024 near Silos 1 and 2 had the highest levels of total uranium in that area, 433 and 576 µg/ℓ, respectively. These total uranium values can be primarily attributed to the presence of uranium-238, with lesser concentrations of uranium-234 and uranium-235/236. Sample ASIT-024 also contained detectable technetium-99 (36.9 pCi/ℓ). The total uranium levels in the samples from ASIT-010, ASIT-025, and ASIT-026 were 231.0, 247.0, and 201.0 µg/ℓ, respectively. These three samples were also evaluated for gross alpha (232.0 pCi/ℓ, 144.0 pCi/ℓ, and 78.0 pCi/ℓ) and gross beta (242.0 pCi/ℓ, 56.0 pCi/ℓ, and 32.0 pCi/ℓ). Nonradioactive chemicals were not analyzed.

Sediment

The sediment data from the RI/FS sampling of the active fly ash disposal area include gross alpha, gross beta, radium-226, radium-228, and total uranium. The sample from ASIT-005 had the highest gross alpha (41.0 pCi/g), gross beta (109.0 pCi/g), radium-226 (2.89 pCi/g), radium-228 (2.77 pCi/g), and total uranium (51.8 µg/g). Sampling location ASIT-004 generally had the next highest concentrations of these constituents, with ASIT-006 and ASIT-007 samples having detectable, although lower concentrations of these radionuclides. Organic compounds were typically not present in detectable quantities, but certain metals and inorganics were detected. A sediment sample from ASIT-007 contained sulfate (697.0 mg/kg), magnesium (21,600 mg/kg), sodium (130 mg/kg), and phosphorous (37.4 mg/kg) and detectable levels of barium, lead, selenium, arsenic, and mercury. These results are similar to those reported for the surface water samples. Radionuclide results from

the inactive fly ash disposal area were similar to those from the active area. Nonradionuclide sediment data were not available at the time of preparation of the SWCR.

Only the sediment sample from ASIT-010, near Silos 1 and 2, was analyzed for both radionuclide and general chemical parameters. The total uranium concentration was 30.3 μg/g. Both the gross alpha and gross beta concentrations were 26.0 pCi/g, and the radium-226 and radium-228 concentrations were similar to those observed for the active fly ash disposal area (detectable but less than 1.0 pCi/g).

4.1.4 Groundwater

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4.1.4 Groundwater

As described in Section 3.1.4, several groundwater monitoring programs have been conducted at the FEMP. The following discussion of the nature and extent of contamination in groundwater at the FEMP is based on data collected from:

- Fernald Litigation Sampling Program (IT 1986)
- Environmental Monitoring (EM) Groundwater Surveillance Program
- Resource Conservation and Recovery Act (RCRA) Detection Program (Round 1 through Round 6)
- RI/FS Groundwater Monitoring Program
- Ongoing RCRA Groundwater Assessment Program

4.1.4.1 "Interim Report - Air, Soil, Water, and Health Risk Assessment in the Vicinity of the FMPC, Fernald, Ohio," (IT 1986)

In order to support the Fernald litigation process, the existing data were reviewed and new analytical and field data analyzed to establish the geographic boundaries of environmental impacts of the FEMP and to assess the associated risks to the local community. The study area encompassed the region within a five-mile radius of the FEMP.

4.1.4.1.1 Radiological Parameters

The background concentration of uranium, 0.5 pCi/ℓ (0.8 µg/ℓ), was estimated by averaging the results of 228 samples collected upgradient of the FEMP from 1978 to 1982 (Dames and Moore, 1985). Wells with uranium concentrations of greater than the 0.5 pCi/ℓ background level were as follows:

- On-property wells
  FMPC-13D (3013), FMPC-18D (3018), IT-1 (2068), IT-2 (2067), IT-5, and IT-6 (3069)

- Off-property wells
  1A (1059), AW (3062), BLK, COLL 1, COLL 2, DH (1058), DS (2061), HK-S (2060), IT-4 (2071), KY, MVRM, and WK.

Among these wells, total uranium concentrations of greater than the proposed 20 µg/ℓ MCL (13 pCi/ℓ for typical FEMP groundwater) were only present in groundwater samples collected from Wells AW,

DS, HK-S, and WK. These four wells are all located south of the FEMP property. Total uranium concentrations in these wells ranged from 31.0 to 183.0 pCi/ℓ.

In addition to total uranium, concentrations of gross alpha, gross beta, and strontium-90 were also found exceeding EPA's drinking water standards or DOE guideline. These wells, the concentration ranges, and the standards are listed as follows:

- Gross Alpha - EPA drinking water standard is 15 pCi/ℓ
  12-3 (2123), 1NH, 2CW, AW (3062), COLL 2, DS (2061), FMPC-18D (3018), FMPC-18S (2018), H-120, HK-S (2060), IT-3, IT-4 (2071), IT-6 (3069), KY, MVRM, STATE 8 (2056), and STATE 10 (2105)
  Gross alpha concentrations in these analyses ranged from 15.6 to 279 pCi/ℓ.

- Gross Beta - DOE guideline is 50 pCi/ℓ
  1A (1059), DS (2061), FMPC-18D (3018), HK-S (2060), AND IT-1 (2068)
  Gross beta concentrations in these analyses ranged from 52.5 to 105 pCi/ℓ.

- Strontium-90 - EPA drinking water standard is 8 pCi/ℓ
  12-3 (2123), 1A (1059), COLL 1, DS (2061), FMPC-18D (3018), IT-1 (2068), and MVRM. Strontium-90 concentrations in these analyses ranged from 8.68 to 69.0 pCi/ℓ.

Elevated concentrations of gross alpha, gross beta, and strontium-90 not only were present in groundwater samples collected from the wells located inside of and immediately downgradient of the FEMP, i.e., east and south, but also in samples collected from upgradient areas, i.e., gross alpha in Wells INH, 12-3, STATE 8, and STATE 10, gross beta in Well 1A, and strontium-90 in Wells 1A and 12-3. These suggest that the FEMP might not be the only source of the elevated concentrations of these parameters.

4.1.4.1.2 Metals

Concentrations of iron ranged from 0.05 to 6.1 mg/ℓ, and concentrations of manganese ranged from below the 0.01 mg/ℓ detection limit to 0.79 mg/ℓ. Although iron and manganese concentrations in the majority of the samples were greater than the 0.3 and 0.05 mg/ℓ Secondary Maximum Contaminant Levels (SMCLs), respectively, their concentrations are typical for groundwater in this area.

With the exception of iron and manganese, the only metals present in groundwater samples with concentrations greater than the EPA drinking water standards were aluminum and lead. Both detections were in a sample from Well FMPC-P3 (4103), which is one of the three production wells located in the former production area. Aluminum and lead concentrations in this sample were 0.3 and 0.013 mg/ℓ, while the EPA standards are 0.2 and 0.005 mg/ℓ, respectively. The cause of this isolated

occurrence at Well FMPC-P3, which is screened at the lowest portion of the Great Miami Aquifer, is not understood.

4.1.4.1.3 General Chemical Parameters

With the exception of chloride and TDS, concentrations of the general chemical parameters did not exceed the EPA drinking water standards. The chloride concentration of 280 mg/ℓ in one sample collected from Well B-3, located east of the FEMP, exceeded the 250 mg/ℓ SMCL. Elevated TDS concentrations, ranging from 510 mg/ℓ to 930 mg/ℓ, occurred in samples from Wells FMPC-13D (3013), BLK, INH, IT-3, and IT-4 (2071). The EPA drinking water standard for TDS is 500 mg/ℓ. The maximum was in the sample from Well FMPC-13D, located at the eastern boundary of the former production area.

4.1.4.1.4 Organic Compounds

Only two organic compounds were found above the contract required quantitation limit (CRQLs) and not related to any laboratory contamination. Carbon disulfide and n-nitroso-di-n-propylamine were detected in Well B-3 at 0.008 and 0.011 mg/ℓ, respectively, and 1,1,1-Trichloroethane was detected in Well HK-S (2060) at 0.013 mg/ℓ. Well B-3 is located east of the FEMP, and Well HK-S is located south of the FEMP.

4.1.4.2 Environmental Monitoring Annual Reports

The environmental monitoring program has been regularly sampling on-property and off-property wells since the early 1980's. Until the RCRA and RI/FS programs began, this program provided the majority of the groundwater data for the FEMP. Sampling and analysis procedures are described in Section 3.2.4. The following discussion is separated into uranium, other radioactive parameters, metals, and other nonradioactive constituents.

4.1.4.2.1 Uranium

Total uranium has been analyzed for in groundwater samples collected from all on- and off-property wells since early 1980's. The following discussion is presented as on-property well results, off-property well results, and comprehensive groundwater monitoring results.

On-Property Well Results

Except for Well 3010 in 1983 and Wells 3003 and 3010 in 1987, none of the annual total uranium averages in these on-property wells exceeded the proposed MCL for uranium, 20 µg/ℓ (or 13 pCi/ℓ) (Table 4-41). The high average in Well 3003 in 1987 was due to a concentration of 677 pCi/ℓ in the last quarter of 1987. Excluding this value, the annual average total uranium concentration in these 15 wells ranged from 0.09 to 18 pCi/ℓ from 1983 to 1990.

TABLE 4-41
HISTORICAL URANIUM CONCENTRATIONS[a]
IN ON-PROPERTY WELL GROUNDWATER
ENVIRONMENTAL MONITORING PROGRAM

Well Location[b]	Annual Average Uranium Concentration (pCi/ℓ)[c]								
	1983	1984	1985	1986	1987	1988	1989[d]	1990	Average[e]
2004	4.40	4.87	5.52	6.10	5.40	5.10	6.25	5.00	5.33
2011	0.60	0.54	0.15	0.14	0.20	0.29	0.17	0.23	0.29
3001	7.60	5.69	6.89	7.80	9.40	8.60	7.60	5.90	7.44
3003	2.10	1.90	1.76	1.40	65.00	6.00	4.40	2.80	10.67
3005	3.10	2.44	2.49	2.70	4.20	2.90	4.00	1.80	2.95
3008	0.67	0.61	0.59	0.68	3.40	0.23	1.16	0.69	1.00
3009	1.10	0.81	0.90	0.68	1.10	3.80	1.31	2.30	1.50
3010	18.00	4.40	13.88	12.00	14.00	8.80	2.80	2.10	9.50
4001	0.40	0.34	0.19	0.14	0.30	0.09	0.14	0.21	0.23
4008	0.27	1.15	0.24	0.20	0.30	0.20	0.80	0.87	0.50
4101	0.67	0.34	0.25	0.20	0.30	0.14	0.24	0.13	0.28
4102	2.00	0.34	0.30	0.14	0.20	0.11	0.17	0.11	0.42
4103	0.20	0.14	0.15	0.14	0.20	0.09	0.10	0.10	0.14
1124	NS[f]	6.43	NS	NS	NS	NS	NS	NS	6.43
TOAB	NS	1.83	NS	NS	NS	NS	NS	NS	1.83

[a]See National Lead of Ohio (NLO),1984-1985, "Feed Materials Production Center (FMPC) Environmental Monitoring Annual Reports for 1983 and 1984" for 1983 and 1984 data. See Westinghouse Materials Company of Ohio (WMCO), 1986-1991, "Feed Materials Production Center (FMPC) Environmental Monitoring Annual Reports for 1985 to 1990" for 1985 to 1990 data.
[b]See Appendix J for historical well identification names.
[c](pCi/ℓ) = picocuries per liter.
[d]Average concentrations listed for 1989 were calculated from the minimum and maximum concentrations reported for each well. A total number of 3 to 4 groundwater samples were analyzed for uranium from each well in 1989.
[e]Based on annual averages.
[f]NS - not sampled.

Groundwater data were obtained from private wells north of the FEMP during 1987 to 1989. These data indicated that background uranium concentrations in the study area ranged from about 0.068 pCi/ℓ to about 2.0 pCi/ℓ. Although not exceeding the proposed MCL, Wells 2004, 3001, 3003, 3005, 3008, 3009, and 1124 show at least once that the annual average total uranium concentration was greater than the background level of 2 pCi/ℓ. Among these wells, Well 1124, which is screened in the perched zone, was only sampled during 1984. The annual average total uranium concentrations in groundwater samples collected from Wells 3001, 3003, and 3008 showed their peaks in 1987 and have decreased since then.

Off-Property Well Results

With the exception of Wells 12, 15, and 17, none of the annual total uranium concentration averages in samples from these wells exceeded the proposed MCL or the background concentration of 2 pCi/ℓ (Table 4-42). Wells 12, 15, and 17 are all located along Paddys Run Road south of the FEMP property (Figure 3-22). The annual average total uranium concentrations in these three wells ranged from 27 to 290 pCi/ℓ. The minimum concentration occurred in Well 17 during 1989, and the maximum value in Well 15 during 1983.

Comprehensive Groundwater Monitoring Results

After the expansion of the environmental monitoring program in 1990, 219 samples, collected from 157 on- and off-property locations, were analyzed for total uranium. The sampling included the on- and off-property wells discussed in previous sections. The highest total uranium concentration, 8,379 pCi/ℓ, was detected in a sample from Well 1022 in the waste pit area. Total uranium concentrations above the 22 pCi/ℓ DOE drinking water guideline were also found in samples from 34 other on-property locations. These results are detailed in WEMCO (1991).

Among the total 35 wells with uranium concentrations above the DOE guideline, 26 are 1000-Series wells, mainly located in the waste pit and former production areas. Uranium concentrations in samples from these wells ranged from 23 pCi/ℓ to 8,379 pCi/ℓ. Other locations found with high uranium concentrations in perched groundwater include the area immediately west of the Silos 1 and 2, the area around the lime sludge ponds west of the former production area, and in the vicinity of the South Field.

The other 9 wells with high uranium concentrations are five 2000-Series wells and four 3000-Series wells, which are all screened in the upper sand and gravel aquifer. These wells are located along the southern boundary of the FEMP property, along Paddys Run Road south of the FEMP property, and in the waste pit and former production areas. Total uranium concentrations ranged from 34 to 207 pCi/ℓ in the five 2000-Series wells, and from 22 to 74 pCi/ℓ in the four 3000-Series wells. The wells with the maximum total uranium concentrations are 2061 and 3084 for the 2000- and 3000-Series wells, respectively.

TABLE 4-42
HISTORICAL URANIUM CONCENTRATIONS[a]
IN OFF-PROPERTY WELL GROUNDWATER
ENVIRONMENTAL MONITORING PROGRAM

Well Location[b]	Annual Average Uranium Concentration(pCi/ℓ)[c]								
	1983	1984	1985	1986	1987	1988	1989	1990	Average[d]
1	0.20	0.34	0.30	0.25	0.20	0.15	0.17	0.14	0.22
2	0.20	0.27	NS[e]	NS	NS	NS	NS	NS	0.24
3	0.27	0.34	0.23	0.29	0.20	0.13	0.17	0.14	0.22
4	1.20	1.29	1.08	1.09	1.40	1.20	1.40	1.40	1.26
5	1.40	1.42	1.31	1.09	1.40	1.20	1.50	1.20	1.32
6	1.60	1.29	1.37	1.08	1.20	NS	NS	NS	1.31
7	0.95	0.95	0.95	0.95	1.1	1.1	1.1	1.0	1.01
8	0.54	0.54	0.53	0.55	0.66	0.59	0.60	0.54	0.57
9	0.81	0.81	0.99	0.81	0.97	0.93	1.0	0.88	0.90
10	1.10	0.34	0.38	0.39	0.47	0.49	0.52	0.47	0.52
11	0.81	0.68	0.81	0.91	1.00	0.99	1.10	1.30	0.95
12	140.00	165.19	140.00	147.00	201.00	170.00	170.00	130.00	157.90
13	0.41	0.41	0.44	0.41	0.50	0.42	0.37	0.54	0.44
14	0.81	0.74	0.73	0.68	0.89	0.82	0.88	1.00	0.82
15	290.00	219.35	204.27	193.00	201.00	190.00	190.00	190.00	209.70
16	0.61	0.41	0.67	0.47	0.48	0.43	0.52	0.47	0.51
17	39.00	36.29	31.15	31.00	40.00	38.00	27.00	30.00	34.06
18	0.34	0.34	0.29	0.30	0.40	0.38	0.34	0.27	0.33
19	0.14	0.20	0.20	0.21	0.20	0.25	0.12	0.14	0.18
20	0.14	0.20	0.16	0.15	0.20	NS	NS	NS	0.17
21	0.27	0.27	0.29	0.29	0.30	0.27	0.25	0.27	0.28
22	NS	0.74	0.76	0.61	0.80	0.81	0.79	0.61	0.73
23	NS	NS	0.55	0.56	0.56	0.55	0.58	0.61	0.57
24	NS	NS	0.32	0.36	0.40	0.46	0.40	0.34	0.38
25	NS	NS	0.27	0.28	0.50	0.19	0.27	0.27	0.30
26	NS	NS	0.24	0.30	0.39	0.17	0.14	0.14	0.23
27	NS	NS	NS	0.38	0.69	0.51	0.50	0.34	0.48

See footnotes at end of table

TABLE 4-42
(continued)

Well Location[b]	Annual Average Uranium Concentration(pCi/ℓ)[c]								
	1983	1984	1985	1986	1987	1988	1989	1990	Average[d]
30	NS	NS	NS	NS	0.40	0.39	0.38	0.34	0.38
31	NS	NS	NS	NS	NS	0.64	NS	NS	0.64
32	NS	NS	NS	NS	NS	NS	0.09	0.09	0.09
33	NS	NS	NS	NS	NS	NS	NS	0.29	0.29
34	NS	NS	NS	NS	NS	NS	0.83	2.80	1.82
35	NS	NS	NS	NS	NS	NS	1.20	1.30	1.25
36	NS	NS	NS	NS	NS	NS	NS	0.81	0.81
37	NS	NS	NS	NS	NS	NS	NS	0.81[f]	0.81
38	NS	NS	NS	NS	NS	NS	NS	0.10	0.10

[a]See National Lead of Ohio (NLO),1984-1985, "Feed Materials Production Center (FMPC) Environmental Monitoring Annual Reports for 1983 and 1984" for 1983 and 1984 data. See Westinghouse Materials Company of Ohio (WMCO), 1986-1991, "Feed Materials Production Center (FMPC) Environmental Monitoring Annual Reports for 1985 to 1990" for 1985 to 1990 data.
[b]See Figure 3-16 for well locations.
[c](pCi/ℓ) = picocuries per liter.
[d]Based on annual averages.
[e]NS - not sampled.
[f]Only one sample was collected from Sampling Location 37 during 1990.

4.1.4.2.2 Other Radioactive Parameters

In addition to total uranium, gross alpha and gross beta were also analyzed in samples from all on-property wells before the expansion of the monitoring program in 1990. However, total uranium was the only radioactive parameter analyzed for in groundwater samples collected from the off-property wells before 1990. After the Comprehensive Groundwater Monitoring Program started, in addition to uranium, gross alpha, and gross beta, radium, strontium, technetium, thorium, cesium, plutonium, ruthenium, and neptunium were also analyzed. The following discussion is presented as on-property well results and comprehensive groundwater monitoring results.

On-Property Well Results

With the exception of Well 3003 in 1984 and Well 3010 in 1984 and 1985, none of the annual gross alpha concentration averages the MCL of 15 pCi/ℓ (Table 4-43). The high average alpha concentration in Well 3003 of 1987 was due to a high value, 54 pCi/ℓ, during the last quarter of 1987. Total uranium was also high in the same sample, as described in Section 4.1.4.2.1. Excluding this value, the annual average gross alpha concentrations in these 15 wells ranged from less than the detection limit of 0.45 pCi/ℓ to 22.7 pCi/ℓ. The maximum value occurred in Well 3010 in 1984.

Annual gross beta average concentrations, which ranged from less than the detection limit of 1.5 pCi/ℓ to 35.5 pCi/ℓ, did not exceed the 50 pCi/ℓ DOE guideline (Table 4-44). As with gross alpha, the maximum gross beta concentration occurred in samples from Well 3010 during 1984.

Samples collected from Well 3010 before 1987 always contained the highest gross alpha concentrations. Well 3010 also had the highest gross beta concentrations. Annual average gross alpha concentrations in Wells 3001 and 3003 and gross beta concentrations in Wells 3003, 3009, and 4102 peaked in 1987 and have decreased since then.

Comprehensive Groundwater Monitoring Results

The major radionuclides of concern at the FEMP, in addition to uranium, include thorium, radium, strontium, and technetium. The DOE guidelines, the numbers of samples with concentrations higher than the DOE guidelines, and the total numbers of samples collected for these four parameters are as follows:

- Thorium - Thorium-232 (2 pCi/ℓ) - 5 out of 158 samples
- Radium - Total Radium (5 pCi/ℓ) - 4 out of 125 samples
- Strontium - Strontium-90 (8 pCi/ℓ) - 2 out of 38 samples
- Technetium - Technetium-99 (4,000 pCi/ℓ) - 2 out of 70 samples.

Thorium concentrations above the DOE guideline occurred only in samples from the perched zone. The highest thorium-232 concentration, 4.1 pCi/ℓ, was found in the sample from Well 1173, located

TABLE 4-43
HISTORICAL GROSS ALPHA CONCENTRATIONS[a]
IN ON-PROPERTY WELL GROUNDWATER
ENVRIONMENTAL MONITORING PROGRAM

Well Location[b]	Annual Average Alpha Concentration (pCi/ℓ)[c]						
	1984	1985	1986	1987	1988	1989[d]	Average[e]
2004	4.49	4.39	4.10	4.00	NS[f]	13.15	6.03
2011	< 1.49	1.08	1.40	< 1.00	0.90	1.40	1.00
3001	7.66	7.55	12.00	15.00	12.00	7.45	10.28
3003	3.38	3.27	3.60	16.00	3.60	5.40	5.88
3005	3.58	3.22	4.10	3.00	2.30	4.05	3.38
3008	1.96	1.94	2.30	1.00	0.45	0.56	1.37
3009	2.58	1.84	1.80	2.00	NS	1.38	1.92
3010	22.69	15.77	14.00	11.00	NS	6.10	13.91
4001	1.05	< 0.75	0.90	< 1.00	< 0.90	1.01	0.71
4008	< 7.15	0.80	0.90	< 1.00	< 0.45	0.81	1.14
4101	2.36	< 2.70	1.40	3.00	< 0.45	1.40	1.62
4102	0.93	1.57	0.90	2.00	1.40	0.68	1.25
4103	0.76	0.97	0.45	< 1.00	0.90	0.68	0.71
1124	4.84	NS	NS	NS	NS	NS	4.84
TOAB	< 2.73	NS	NS	NS	NS	NS	< 2.73

[a]See National Lead of Ohio (NLO), 1985, "Feed Materials Production Center (FMPC) Environmental Monitoring Annual Reports for 1984" for 1984 data. See Westinghouse Materials Company of Ohio (WMCO), 1986-1990, "Feed Materials Production Center (FMPC) Environmental Monitoring Annual Reports for 1985 to 1989" for 1985 to 1989 data.
[b]See Appendix J for historical well identification names.
[c](pCi/ℓ) = picoCuries per liter.
[d]Average concentrations listed for 1989 were calculated from the minimum and maximum concentrations reported for each well. A total number of 2 to 3 groundwater samples were analyzed for gross alpha from each well in 1989. Half of the detection limit was used to calculate the average when a non-detect occurred.
[e]Based on annual averages.
[f]NS - not sampled.

TABLE 4-44
HISTORICAL GROSS BETA CONCENTRATIONS[a]
IN ON-PROPERTY WELL GROUNDWATER
ENVIRONMENTAL MONITORING PROGRAM

Well Location[b]	Annual Average Beta Concentration (pCi/ℓ)[c]						
	1984	1985	1986	1987	1988	1989[d]	Average[e]
2004	6.30	7.22	7.70	7.10	NS[f]	11.00	7.86
2011	2.65	< 1.89	3.20	2.10	4.10	2.25	2.54
3001	16.24	9.33	10.00	8.10	8.10	7.90	9.95
3003	5.27	5.16	5.40	18.00	6.30	8.45	8.10
3005	5.78	4.16	5.90	5.40	4.10	6.30	5.27
3008	3.34	3.11	4.10	5.30	3.20	2.70	3.63
3009	4.02	4.21	6.80	15.00	NS	8.15	7.64
3010	35.45	31.83	23.0	27.0	NS	20.00	27.46
4001	1.42	1.33	1.90	< 1.50	1.80	1.40	1.43
4008	3.31	1.48	1.80	1.70	1.80	2.25	2.06
4101	4.49	3.98	4.10	5.10	5.00	4.75	4.57
4102	1.99	1.58	1.80	3.00	1.80	1.35	1.92
4103	2.32	1.71	3.20	2.30	1.80	1.60	2.16
1124	7.19	NS	NS	NS	NS	NS	7.19
TOAB	26.54	NS	NS	NS	NS	NS	26.54

[a]See National Lead of Ohio (NLO), 1985, "Feed Materials Production Center (FMPC) Environmental Monitoring Annual Reports for 1984" for 1984 data. See Westinghouse Materials Company of Ohio (WMCO), 1986-1990, "Feed Materials Production Center (FMPC) Environmental Monitoring Annual Reports for 1985 to 1989" for 1985 to 1989 data.
[b]See Appendix J for historical well identification names.
[c](pCi/ℓ) = picoCuries per liter.
[d]Average concentrations listed for 1989 were calculated from the minimum and maximum concentrations reported for each well. A total number of 2 to 3 groundwater samples were analyzed for gross beta from each well in 1989. Half of the detection limit was used to calculate the average when a non-detect occurred.
[e]Based on annual averages.
[f]NS - not sampled.

in the southeast corner of the former production area. The highest total radium concentration, 20 pCi/ℓ, was in a sample from Well 2067, located south of the sewage treatment plant and east of the production area. Strontium-90 concentrations greater than the DOE guideline were found in Wells 1039 and 2021, at 8.6 and 21 pCi/ℓ, respectively. Finally, technetium-99 concentrations higher than the DOE guideline occurred in Wells 2019 and 2021, located in the waste pit area (WEMCO 1991). Gross alpha activity was monitored to indicate areas of concern for radionuclides. Thirty-eight of 95 samples showed activities that were higher than the DOE guideline. The majority of these wells are located in the former production area.

4.1.4.2.3 Metals

The following discussion of off-property well results and comprehensive groundwater monitoring results is based on the summary presented in Appendix K.

Off-Property Well Results

Of the metals analyzed, no DOE or EPA standards have been established for calcium, potassium, magnesium, sodium, and nickel. Concentrations of iron and manganese were generally higher than the SMCLs recommended by the EPA. However, their concentrations are typical for groundwater in this area, and may be due to natural variation. Concentrations of silver, barium, cadmium, chromium, copper, lead, and zinc in groundwater samples collected from the off-property private wells have always been less than their respective MCLs or SMCLs.

The average arsenic concentration in Well 19 and the average selenium concentrations in Wells 19 and 20 exceed their MCLs of 0.05 and 0.01 mg/ℓ, respectively. Concentrations of arsenic and selenium in groundwater samples collected from Well 19 during 1988 and 1989 exceeded the MCLs. The only sample collected from Well 20, which occurred in 1987, had a selenium concentration of 0.034 mg/ℓ, which also exceeded the MCL. Wells 19 and 20 are both located along New Haven Road south of the FEMP. Although selenium concentrations were generally lower than the MCL, during 1989, 11 other privately-owned wells had selenium concentrations ranging from 0.011 to 0.016 mg/ℓ, slightly exceeding the MCL. Samples from Well 4 during 1987 and 1988 showed selenium concentrations of 0.011 and 0.014 mg/ℓ, which also exceeded the MCL.

Comprehensive Groundwater Monitoring Results

The metals analyzed for after the expansion of the environmental monitoring program in 1990 are those in the EPA's HSL. Among those metals, the ones of primary concern at the FEMP are as follows:

- Arsenic
- Barium
- Cadmium
- Chromium
- Lead
- Mercury
- Selenium
- Silver

These metals were selected because they are a potential threat to public health. Analyses of samples from on-property monitoring wells indicated that arsenic and cadmium were the only metals that exceeded the MCLs. Arsenic concentrations above the 0.05 mg/ℓ MCL were found only in Well 3066, which is located at the outlet at the northeast corner of the FEMP property. Concentrations of arsenic in this well ranged from 0.082 to 0.110 mg/ℓ in 1990. Since this well is upgradient to the FEMP, it is not likely that the elevated arsenic concentrations are related to the FEMP. The annual cadmium concentration was above the 0.01 mg/ℓ MCL at only two locations, Wells 1342 (0.012 mg/ℓ) and 3010 (0.069 mg/ℓ). Well 1342 is located in the vicinity of Plant 1 within the former production area and was screened in the perched zone. Well 3010 is located along the western boundary of the former production area and directly downgradient from the waste pit area.

4.1.4.2.4 Other Nonradioactive Constituents

Chloride, sulfate, nitrate, and pH were analyzed for in groundwater samples collected from the traditional on-property wells during 1984 to 1990. Nitrate was also analyzed for in groundwater samples collected from off-property privately-owned wells during 1984 and 1985. Detailed sampling frequencies for specific wells at different locations are addressed in Section 3.1.4. The following discussion is presented as on-property well results, off-property well results, and comprehensive groundwater monitoring results.

On-Property Well Results

Chloride, nitrate nitrogen, and/or sulfate exceeding EPA's drinking water standards occurred only in Wells TOAB and 3010 (Table 4-45). Both of these wells are located in the former production area. Chloride and sulfate concentrations exceeding the SMCLs were found in samples from Well TOAB during 1984. However, no sample has been collected from this well subsequently.

Samples from Well 3010 contained nitrate nitrogen and sulfate concentrations higher than the EPA's drinking water standards of 10 and 250 mg/ℓ, respectively. In Well 3010, the annual average nitrate nitrogen concentrations ranged from 229.5 mg/ℓ in 1985 to less than the detection limit of 0.10 mg/ℓ in 1990, and the annual average sulfate concentrations ranged from 745.6 mg/ℓ in 1984 to 324.5 mg/ℓ in 1990. Both nitrate nitrogen and sulfate in Well 3010 have shown a strong trend of decreasing throughout the years. Although not exceeding the 250 mg/ℓ MCL, Well 3010 shows the highest chloride concentrations among the 13 traditional on-property wells. As listed in Table 4-45, the annual average chloride concentrations in groundwater sampled from Well 3010 ranged from 54.5 to 79.0 mg/ℓ. They are considered elevated when compared to the average chloride concentrations in groundwater samples collected from the other wells which ranged from 11.0 to 36.9 mg/ℓ.

The pH values appear to be stable throughout the year, with the exception of Well 3008 (Table 4-45). The annual average pH values in samples from this well reached the maximum value of 8.8 in 1988

TABLE 4-45
HISTORICAL GENERAL CHEMISTRY IN OFF-PROPERTY WELL GROUNDWATER[a]
ENVIRONMENTAL MONITORING PROGRAM

Well Location[b]	Chloride Average (mg/ℓ)[c] Range[d] (mg/ℓ)	Nitrate Nitrogen Average (mg/ℓ)[c] Range[d] (mg/ℓ)	Sulfate Average (mg/ℓ)[c] Range[d] (mg/ℓ)	pH Value Average Range
2004	22.7 21.8 - 24.0	1.40 0.08 - 3.23	64.2 58.0 - 77.5	7.5 7.4 - 7.8
2011	23.4 19.2 - 32.0	0.13 0.08 - 0.30	84.7 43.0 - 112.0	7.6 7.4 - 8.1
3001	18.8 17.0 - 20.3	0.09 <0.10 - 0.13	69.0 41.5 - 86.0	7.5 7.3 - 7.6
3003	22.6 20.5 - 27.0	0.06 <0.10 - 0.13	80.6 56.5 - 97.7	7.6 7.4 - 7.9
3005	20.4 16.0 - 27.0	0.06 0.08 - <0.13	76.7 67.0 - 86.0	7.5 7.4 - 7.7
3008	18.6 16.0 - 20.2	0.06 0.08 - <0.11	43.7 15.5 - 77.0	7.9 7.4 - 8.8
3009	21.2 20.0 - 22.0	1.16 <0.10 - 2.40	63.7 37.5 - 76.5	7.7 7.4 - 7.9
3010	66.6 54.5 - 79.0	96.9 <0.10 - 229.5	613.7 324.5 - 745.6	7.0 6.8 - 7.2
4001	24.6 20.3 - 33.5	0.06 <0.10 - 0.13	17.4 6.0 - 37.0	7.5 7.3 - 7.6
4008	11.0 8.0 - 12.3	0.06 <0.10 - <0.21	7.9 6.0 - 12.0	7.5 7.4 - 7.8
4101	36.9 31.0 - 41.2	0.42 0.13 - 1.00	111.2 79.0 - 159.0	7.5 7.3 - 7.6
4102	23.0 18.0 - 29.0	0.10 0.08 - 0.20	33.4 8.8 - 78.3	7.5 7.4 - 7.6
4103	13.0 11.5 - 16.0	0.07 0.08 - 0.13	42.6 26.0 - 68.0	7.6 7.5 - 7.8
1124[e]	22.8	2.28	132.4	7.3
TOAB[e]	559.8	<0.11	608.0	7.8

[a]Data can be found in Westinghouse Materials Company of Ohio (WMCO), 1987-1991, "Feed Materials Production Center (FMPC) Enviromental Monitoring Annual Reports for 1986 to 1990." Data listed are calculated based on annual averages.
[b]See Figure 3-16 for well locations.
[c](mg/ℓ) = milligrams per liter.
[d]Ranges listed were based on annual averages. The minimum concentration shown for each well is either the lowest detection limit or the lowest positively detected concentration, whichever is smaller. The maximum concentration shown for each well is the highest positively detected concentration or, when the parameter has never been detected in groundwater collected from the specific well, the highest detection limit ever applied.

and have decreased since then. Well 3008 is located immediately downgradient from the denitrification surge lagoon west of the former production area.

Off-Property Well Results

Nitrate nitrogen was the only non-radioactive parameter other than metals analyzed for in samples from off-property wells. Samples analyzed for nitrate nitrogen were only collected from off-property wells during 1984 and 1985. Annual average nitrate nitrogen concentrations were all below the 10 mg/ℓ MCL.

Comprehensive Groundwater Monitoring Results

The non-radioactive constituents analyzed for in groundwater samples collected under the Comprehensive Groundwater Monitoring Program are the ones listed in the EPA's HSL. A complete list of all of the chemicals sampled for at the FEMP in 1990 and the sampling results can be found in the 1990 Groundwater Monitoring Annual Report. In addition to priority pollutant metals, fluoride, nitrate, and VOCs were analyzed for in samples collected in 1990.

Concentrations of nitrate and some VOCs exceeded their MCLs in on-property wells. Nitrate nitrogen concentrations at 16 locations exceeded the 10 mg/ℓ MCL. These 16 locations and their concentration ranges are as follows:

- 1000 Series Wells - Wells 1025, 1028, 1031, 1054, and 1081
  Concentrations ranged from 15 to 247 mg/ℓ

- 2000 Series Wells - Wells 2019, 2021, 2022, 2084, 2095, 2643, and 2649
  Concentrations ranged from 11 to 74 mg/ℓ

- 3000 Series Wells - Wells 3004, 3019, and 3084
  Concentrations ranged from 16 to 61 mg/ℓ.

The majority of these wells are located in the vicinity of the waste pit area, with the exception of Wells 1032, 1054, and 2095. Well 1032 is located between Paddys Run and Silos 1 and 2. Well 1054 is located in the former production area. Well 2095 is situated along Paddys Run Road south of the FEMP.

Among the 197 locations sampled for VOCs in 1990, six contained consistent concentrations of VOCs. The wells and the VOCs detected in these wells are as follows:

- Well 1031 -
  1,1,1-Trichloroethane, 1,1-Dichloroethane, 1,1-Dichloroethene, 1,2-Dichloroethane, 1,2-Dichloroethene (total), acetone, methylene chloride, tetrachloroethene, toluene, and trichloroethene

- Well 1041 - 1,1-Dichloroethane
- Well 2015 - 1,1,1-Trichloroethane
- Well 2060 - 1,1,1-Trichloroethane
- Well 2649 - 1,1,1-Trichloroethane, 1,1-Dichloroethane, 1,2-Dichloroethene (total), and trichloroethene
- Well 3126 - Acetone

Among these compounds, only trichloroethene in samples from Wells 1031 and 2649 exceeded the 0.005 mg/ℓ MCL, ranging from 0.137 to 0.334 mg/ℓ.

4.1.4.3 RCRA Detection Program

Six rounds of groundwater sampling were conducted at the FEMP from 1985 to 1987 to characterize groundwater quality and to identify RCRA regulated hazardous and radiological constituents that may be present in groundwater. Results from Well 1012 (or MW-12 as indicated in the RCRA reports) were used to characterize background groundwater quality for perched zones. Analytical results from Collector Well 2 (Coll 2 or SW-2 as identified in the RCRA reports) were used to determine background groundwater quality for the Great Miami Aquifer. The other monitoring wells sampled are listed in Section 3.1.4.4.

4.1.4.3.1 Radiological Constituents

Uranium, radionuclide scan, total radium, gross alpha, and gross beta analyses were conducted during at least two rounds of sampling. The radionuclides listed in Table 3-16 were analyzed in samples from Wells 1012, 1019, 1021, 1022, Coll 2, 2014, 2018, 2019, 3010, 3014, 4001 during August 1985. In addition, radium-226 and -228 were analyzed in samples from all RCRA monitoring wells during Round 6. The following discussion is separated into the perched zone groundwater and the Great Miami Aquifer. Radioactivity in scans of 73 samples was not detected above the 5 pCi/ℓ detection limit. Total uranium, total radium, gross alpha, and gross beta data are summarized in Table 4-46, and data for each well are included in Table L-1 of Appendix L. Analytical results of other radiological constituents during Round 1 are included in Table 4-47.

Perched Groundwater

From Round 1 to Round 6 RCRA sampling, total uranium was detected in 27 of 34 samples from Wells 1012, 1019, 1020, 1021, 1022, and 1060 (Table 4-46). With the exception of Wells 1012 and 1060, these wells are all located in the waste pit area. The maximum was in a sample from Well 1021. Total uranium concentrations above background were detected in samples from every 1000 Series RCRA monitoring well in the waste pit area.

TABLE 4-46
TOTAL URANIUM, TOTAL RADIUM, GROSS ALPHA, AND GROSS BETA[a] IN GROUNDWATER SAMPLES COLLECTED FROM RCRA DETECTION PROGRAM

Wells[b]	Total Uranium Average (µg/ℓ)[c] Range[d] (µg/ℓ)	Total Radium Average (pCi/ℓ)[e] Range[d] (pCi/ℓ)	Gross Alpha Average (pCi/ℓ)[e] Range[d] (pCi/ℓ)	Gross Beta Average (pCi/ℓ)[e] Range[d] (pCi/ℓ)
Glacial Overburden Background (Well 1012)	1.6 < 0.1 - 1.5	1.8 < 1.0 - < 5.0	8.5 0.5 - 21.0	19.5 5.0 - 78.0
1000 Series Wells	1745 1.1 - 9612	3.8 < 1.0 - 21.1	143.2 < 1.0 - 1370	346 3.0 - 3310
Sand and Gravel Aquifer Background (Collector Well 2)	1.6 < 0.6 - 0.8	3.6 < 1.0 - 7.7	2.7 < 1.0 - 6.3	8.2 2.5 - 17.0
2000 Series Wells	67.2 < 0.1 - 591	8.1 < 1.0 - 130	13.3 < 0.5 - 70	166.8 < 1.0 - 2270
3000 Series Wells	265.1 0.6 - 17462	1.9 < 1.0 - 5.9	39.5 0.5 - 2980	175.8 < 1.0 - 14100
4000 Series Wells	0.7 0.1 - 2.3	1.8 < 1.0 - < 5.0	3.9 0.5 - 13	5.0 < 1.0 - 29

[a]Data can be found in RCRA Round 1 to Round 6 Reports, Dames and Moore, 1985a; 1985b; 1986; 1987a; 1987b; 1988.
[b]Monitoring wells used for RCRA detection program included:

1000 Series Wells: Wells 1019, 1020, 1021, 1022, and 1060
2000 Series Wells: Wells 2004, 2011, 2013, 2014, 2015, 2016, 2017, 2018, 2019, 2020, 2021, 2022, 2060, and 2061
3000 Series Wells: Wells 3001, 3003, 3005, 3008, 3009, 3010, 3013, 3014, 3016, 3017, 3018, 3019, 3020, and 3062
4000 Series Wells: Wells 4001, 4008, 4015, 4101, 4102, and 4103.

[c](µg/ℓ) = micrograms per liter.
[d]The minimum concentration shown for each well is either the lowest detection limit or the lowest positively detected concentration, whichever is smaller. The maximum concentration shown for each well is the highest positively detected concentration or, when the parameter has never

TABLE 4-47
OTHER RADIOLOGICAL CONSTITUENTS CONCENTRATIONS[a]
IN ROUND 1 RCRA DETECTION PROGRAM GROUNDWATER SAMPLES

Well Location[b]	Concentration (pCi/ℓ)[c]						
	^{40}K	^{226}Ra	^{228}Ra	^{99}Tc	^{228}Th	^{230}Th	^{232}Th
Background (1012)	< 10.0	< 10.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
1019	< 10.0	< 10.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
1021	15.0	< 10.0	12.0	< 5.0	< 5.0	< 5.0	< 5.0
1022	75.0	< 50.0	75.0	< 5.0	< 5.0	< 5.0	88.0
Background (Coll 2)	< 10.0	< 10.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
2014	< 10.0	< 10.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
2018	< 10.0	< 10.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
2019	40.0	< 10.0	70.0	< 5.0	< 5.0	< 5.0	80.0
3010	< 10.0	< 10.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
3014	< 10.0	< 10.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
4001	< 10.0	< 10.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0

Well Location[b]	Concentration (pCi/ℓ)[c]						
	^{137}Cs	^{90}Sr	^{106}Ru	^{237}Np	^{238}Pu	^{239}Pu	^{240}Pu
Background (1012)	< 5.0	< 5.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0
1019	22.0	< 5.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0
1021	48.0	14.0	15.0	14.0	< 40.0	< 40.0	< 40.0
1022	115.0	28.0	80.0	50.0	< 100.0	< 100.0	< 100.0
Background (Coll 2)	< 5.0	< 5.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0
2014	12.0	< 5.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0
2018	12.0	< 5.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0
2019	110.0	24.0	75.0	< 10.0	< 100.0	< 100.0	< 100.0
3010	12.0	< 5.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0
3014	< 5.0	< 5.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0
4001	< 5.0	< 5.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0

[a]Data can be found in RCRA Round 1 Report, Dames and Moore, 1985a. Sampling for these analyses was conducted in August 1985.

See footnotes at end of table

TABLE 4-47
(continued)

[b]See Appendix J for historical well identification names.

[c](pCi/ℓ) = picoCuries per liter.

Total radium was only analyzed in groundwater samples collected during Rounds 1, 2, and 5 RCRA sampling. Radium-226 and -228 were also analyzed in groundwater samples collected from 1000 Series wells during Round 1 and Round 6 sampling. Total radium was detected only in samples from Wells 1019 (5.84 pCi/ℓ) and 1021 (21.1 pCi/ℓ) during Round 2 RCRA sampling. The only radium isotope detected was radium-228, ranging from 4 to 75 pCi/ℓ in Wells 1021 and 1022.

Radium-228 is an alpha-decay product of thorium-232. The elevated concentration in the sample from Well 1022 corresponded with the 88 pCi/ℓ thorium-232 in the sample and generally higher gross alpha activity concentrations detected in groundwater samples collected from this well.

Gross alpha and beta concentrations are summarized in Table 4-46. Gross alpha was not detected in samples from Well 1060, located south of the FEMP property. Gross alpha in samples from 1000 Series wells in the waste pit area ranged up to 1370 pCi/ℓ. Both average gross alpha and gross beta concentrations in 1000-Series wells exceeded the 15 pCi/ℓ EPA drinking water standard and the 50 pCi/ℓ DOE guideline (Table 4-46).

Other radiological constituents were also analyzed in samples collected from Wells 1012, 1019, 1021, and 1022 during Round 1 RCRA sampling (Table 4-47). None of these constituents were detected at concentrations greater than the detection limits in the sample from the background well, Well 1012. Cesium-137, strontium-90, ruthenium-106, and neptunium-237 were all detected in at least one of the other wells.

Great Miami Aquifer Groundwater

Total uranium was analyzed for in 178 samples collected from one collector well located by the Great Miami River, fourteen 2000 Series wells, fourteen 3000 Series wells, and six 4000 Series wells (Table 4-46. Samples collected from the majority of the sand and gravel aquifer wells had uranium concentrations above background. Total uranium concentrations of less than or close to the background concentrations were present only in samples from Wells 2011, 2013, 2020, 3008, 3009, 3017, 3018, and 3020, and the 4000 Series wells. Uranium concentrations in aquifer wells are generally much lower than those in perched groundwater in the waste pit area. However, samples from certain 2000 and 3000 Series wells exceeded the proposed MCL for total uranium, 20 µg/ℓ. These wells are either located in the waste pit area, i.e., Wells 3001, 3003, and 3019, or in the South Plume, i.e., Wells 2014, 2015, 2060, 2061, 3014, and 3062.

Total radium was analyzed in samples collected during Rounds 1, 2, and 5 RCRA sampling. Radium-226 and -228 were also analyzed in samples collected from Collector Well 2 and Wells 2014, 2018, 2019, 3010, 3014, and 4001 during Round 1 sampling and the entire aquifer during Round 6. Total radium was found at levels above the detection limits only in one Round 2 sample from the background well (Table 4-46). Radium isotopes were not found at concentrations greater than the detection

limits in any samples collected from this well. Total radium was detected only in Wells 2015, 2019, 2020, 2021, 2060, 2061, and 3020 during Round 2 and in a Round 5 sample from Well 2021. Total radium concentrations in these samples ranged from less than the detection limit of 1.0 pCi/ℓ to 130 pCi/, with the maximum concentration in the sample from Well 2019. Radium-226 was detected in samples from Wells 2061 and 3003 during Round 6 at 1 and 16 pCi/ℓ, respectively. Radium-228 was detected in samples from Well 2019 at 70 pCi/ℓ during Round 1 and from Wells 2021 and 3003 during Round 6 at 12 and 294 pCi/ℓ, respectively.

Although gross alpha concentrations greater than background were found in samples from many wells (Table 4-46), concentrations exceeding the 15 pCi/ℓ drinking water standard were found only in Wells 2014, 2015, 2018, 2019, 2021, 2021, 2060, 2061, 3003, and 3018. Again, these wells are either located in the waste pit area or in the South Plume.

The maximum gross beta concentration occurred in Well 3003 during Round 6 RCRA sampling (Table 4-46). Gross beta concentrations exceeding the 50 pCi/ℓ DOE guideline were found in samples from Wells 2019, 2021, 2022, 3003, 3010, which are located either in the waste pit area or directly east of the waste pit area, and Well 2014, 2015, 2060, and 2061 which are located near or south of the confluence of Paddys Run and the SSOD.

Other radiological constituents were also analyzed in regional aquifer samples during Round 1 sampling (Table 4-47). None of these constituents were detected in the sample from Collector Well 2. Radiological constituents found at levels above the detection limits in the other wells include cesium-137, potassium-40, thorium-232, strontium-90, and ruthenium-106.

4.1.4.3.2 Metals

Seventeen metals were analyzed for in samples collected under Round 1 to Round 6 RCRA sampling. The following discussion is separated into the perched zone groundwater and the sand and gravel aquifer. Results are summarized in Table 4-48.

Perched Groundwater

No MCLs or SMCLs have been set for calcium, magnesium, potassium, and sodium in groundwater. Concentrations of calcium and magnesium in perched zone monitoring wells were generally greater than the background concentrations (Table 4-48). Concentrations of potassium and sodium in the background well were generally greater than the concentrations in groundwater from the monitoring wells. It is noted that the background well, Well 1012, was screened at an elevation very close to the bedrock. The groundwater chemistry in this well may be significantly influenced by the bedrock.

Iron and manganese concentrations in samples from perched zone wells varied dramatically from one round to the other. This is most likely due to the high redox sensitivity of these two metals in nature.

TABLE 4-48
METALS IN GROUNDWATER SAMPLES[a]
COLLECTED FROM RCRA ROUND 1 TO ROUND 6 SAMPLING

Metal	Background Average (mg/ℓ)[b]	Background Range (mg/ℓ)	Background Frequency of Detection	Average (mg/ℓ)	Monitoring Results Range (mg/ℓ)	Frequency of Detection
			Perched Groundwater			
Arsenic	0.003	0.003 U[c] - 0.004	2/6	0.005	0.003 U - 0.03	14/30
Barium	0.1	0.2 U - 0.2 U	0/6	0.179	0.2 U - 0.863	7/30
Cadmium	0.001	0.001 U - 0.002 U	0/6	0.001	0.001 U - 0.003	2/30
Calcium	44.0	17.6 - 97.9	6/6	253	77.3 - 539	30/30
Chromium (Total)	0.012	0.005 U - 0.056	2/6	0.013	0.005 U - 0.101	10/30
Chromium (Hexavalent)	0.003	0.005 U - 0.01 U	0/6	0.003	0.005 U - 0.01 U	0/30
Copper	0.016	0.025 U - 0.034	1/6	0.02	0.025 U - 0.105	5/30
Iron	6.59	0.064 - 24.4	6/6	8.79	0.05 U - 69.8	28/30
Lead	0.032	0.005 U - 0.18	1/6	0.003	0.005 U - 0.18	2/30
Magnesium	15.2	6.2 - 43	6/6	78.6	7.8 - 194	30/30
Manganese	0.118	0.015 U - 0.404	4/6	1.38	0.015 U - 3.77	26/30
Mercury	0.0002	0.0002 U - 0.0009	1/6	0.0001	0.0002 U - 0.0003	1/30
Nickel	0.012	0.005 U - 0.054	2/6	0.016	0.005 U - 0.137	13/30
Potassium	12.4	10.6 - 16.3	6/6	9.09	0.97 - 34.1	27/27
Selenium	0.001	0.003 U - 0.004 U	0/6	0.001	0.003 U - 0.005 U	0/30
Silver	0.015	0.03 U - 0.03 U	0/6	0.015	0.002 U - 0.03 U	0/30
Sodium	225	191 - 246	6/6	59.2	2.67 - 418	30/30
Zinc	0.031	0.003 U - 0.108	2/6	0.069	0.003 U - 0.48	14/30

See footnotes at end of table

TABLE 4-48
(continued)

Metal	Background Average (mg/ℓ)[b]	Background Range (mg/ℓ)	Background Frequency of Detection	Average (mg/ℓ)	Monitoring Results Range (mg/ℓ)	Frequency of Detection
			Sand and Gravel Aquifer Groundwater			
Arsenic	0.002	0.003 U - 0.005 U	0/6	0.003	0.001 U - 0.035	15/201
Barium	0.1	0.2 U - 0.2 U	0/6	0.1	0.2 U - 0.2	1/201
Cadmium	0.017	0.001 U - 0.2 U	0/6	0.001	0.001 U - 0.005	4/201
Calcium	100	93.6 - 109	6/6	127	14.9 - 1232	201/201
Chromium (Total)	0.003	0.005 U - 0.005 U	0/6	0.006	0.004 - 0.159	22/200
Chromium (Hexavalent)	0.003	0.005 U - 0.005 U	0/6	0.003	0.004 - 0.03	6/201
Copper	0.013	0.025 U - 0.025 U	0/6	0.019	0.019 - 0.289	23/201
Iron	0.052	0.05 U - 0.11	2/6	3.10	0.005 U - 61.8	170/201
Lead	0.003	0.005 U - 0.005 U	0/6	0.004	0.005 U - 0.1	18/201
Magnesium	28.0	26.7 - 28.7	6/6	28	18 - 93	201/201
Manganese	0.144	0.13 - 0.167	6/6	0.43	0.005 U - 5.5	160/201
Mercury	0.0001	0.0002 U - 0.0002 U	0/6	0.0001	0.0002 U - 0.0007	6/201
Nickel	0.003	0.005 U - 0.005 U	0/6	0.004	0.001 U - 0.039	26/201
Potassium	2.63	2.38 - 3.1	6/6	3.55	0.525 - 44.3	201/201
Selenium	0.001	0.003 U - 0.004 U	0/6	0.001	0.003 U - 0.013	2/201
Silver	0.015	0.03 U - 0.03 U	0/6	0.015	0.03 U - 0.03 U	0/201
Sodium	57.6	11.2 - 270	6/6	24.1	3.99 - 255	201/201
Zinc	0.021	0.02 U - 0.066	1/6	0.029	0.003 U - 0.402	40/201

[a]Data can be found in RCRA Round 1 to Round 6 Reports, Dames and Moore, 1985a; 1985b; 1986; 1987a; 1987b; 1988.
[b](mg/ℓ) = milligrams per liter.
[c]U = below the indicated detection limit.

Surface water seepage rates and sample acidification, filtration, and residence time prior to analysis all have great impact on analytical results of these two metals. The majority of these analytical results exceeded the SMCLs of 0.3 and 0.05 mg/ℓ, for iron and manganese, respectively (Table 4-48).

Groundwater samples contained total chromium, lead, and nickel exceeding the EPA drinking water standards, i.e., 0.1, 0.005, and 0.1 mg/ℓ, respectively, were only sporadically found in the perched zone wells, including Wells 1012 (the background well), 1020, and 1021. Concentrations of other metals did not exceed MCLs or SMCLs.

Great Miami Aquifer Groundwater

As stated previously, no standards have been set by EPA for calcium, magnesium, potassium, and sodium in groundwater. Calcium concentrations in Wells 2019, 2021, 2022, 3010, 3013, and 3019, and magnesium concentrations in Wells 2022, 3010, 3013 were consistently greater than the background values (Tables 4-48). Potassium concentrations in Wells 2014, 2019, 2021, 2022, 3019, 3010, and 3013, and sodium concentrations in Wells 2019, 3010, 3013, and 3019 were also generally greater than the background values. With the exception of Well 2014, these wells are all located in the waste pit and the former production areas. Well 2014 is located in the vicinity of the South Field.

Iron and manganese concentrations varied significantly from one round to the other. The majority of the results exceeded the SMCLs of these two metals, 0.3 and 0.05 mg/ℓ, respectively (Table 4-48). However, high iron and manganese concentrations are typical for groundwater in this area.

Total chromium concentrations exceeding the 0.1 mg/ℓ drinking water standard were only found in Round 1 samples collected from three monitoring wells, 2014, 2018, and 2019. Total chromium in these three samples ranged from 0.133 to 0.159 mg/ℓ. Well 2014 is located south of the South Field. Well 2018 is located southeast of the K-65 silos, and Well 2019 is located east of Waste Pit 4.

Lead is the only metal that was repeatedly found at concentrations exceeding the 0.005 mg/ℓ MCL, with recurrent detections in samples from Wells 2014, 2018, and 3014. Lead concentrations ranging from 0.009 to 0.1 mg/ℓ were found in samples from Well 2014 during Round 1 to Round 4. However, a lead concentration of less than the 0.005 mg/ℓ detection limit was reported in the sample from Well 2014 during Round 5 sampling in 1987. Lead in samples from Well 2018 ranged from below the 0.005 mg/ℓ detection limit to 0.047 mg/ℓ. Lead concentrations exceeding the MCL were reported in samples from this well during Rounds 1, 2, and 5 sampling. Lead concentrations of 0.011 and 0.006 mg/ℓ were also reported in samples from Well 3014 during Round 1 and Round 6, respectively. However, lead was not detected in this well from Round 2 to Round 5. Nonrepeatable MCL-exceeding lead concentrations were also reported in other aquifer wells, including Wells 2015, 2017, 2019, 2022, 3008, 4001, and 4008. Concentrations of other metals did not exceed MCLs or SMCLs.

4.1.4.3.3 General Chemical Parameters

MCLs or SMCLs are available for the following general chemical parameters:

- Chloride - 250 mg/ℓ SMCL
- Cyanide - 0.2 mg/ℓ MCL
- Fluoride - 2 mg/ℓ SMCL
- Nitrate nitrogen - 10 mg/ℓ MCL
- Sulfate - 250 mg/ℓ SMCL
- pH - 6.5 ~ 8.5 SMCL
- TDS - 500 mg/ℓ SMCL

The following discussion is separated into perched zone groundwater and sand and gravel aquifer groundwater. The results are summarized in Table 4-49.

Perched Groundwater

pH, cyanide, and fluoride in perched groundwater were well within drinking water standards (Table 4-49). Phosphorous concentrations varied from one round to the other. Phosphorus concentrations in the majority of the samples were generally greater than background values.

Nitrate nitrogen concentrations greater than the 10 mg/ℓ MCL were found only in two samples. One was collected from Well 1022 during Round 2, and the other was collected from Well 1060 during Round 3. The elevated nitrate nitrogen concentration, 10.5 mg/ℓ, was inconsistent with the other results, which ranged from less than the 0.02 mg/ℓ detection limit to 1.24 mg/ℓ. However, nitrate nitrogen concentrations in samples from Well 1060, ranging from 4.4 to 11.2 mg/ℓ, were consistently greater than those in samples from the other 1000 Series wells.

Chloride concentrations greater than the 250 mg/ℓ SMCL were consistently detected only in samples from Well 1019. They ranged from 265 to 1030 mg/ℓ, compared to the average background concentration of 102 mg/ℓ.

Anomalous CODs, conductivities, sulfate, and TDS were found in groundwater samples from two perched groundwater wells, 1019 and 1022. Average CODs in these two wells, 21.8 and 38.3 mg/ℓ, respectively, were generally at least twice the background values (Table 4-49). Conductivities in samples from these two wells, ranging from 1,950 to 5,310 µmhos/cm, were greater than the those in background samples. Sulfate concentrations, ranging from 280 to 1320 mg/ℓ, were consistently greater than the 250 mg/ℓ SMCL or background. Elevated sulfate concentrations were also found in Well 1021, which showed an average value of 239 mg/ℓ. The majority of the samples showed TDS above the 500 mg/ℓ SMCL (Table 4-49). However, only in Wells 1019 and 1022 were TDS values, ranging from 1820 to 3570 mg/ℓ, greater than the background range.

TABLE 4-49
GENERAL CHEMICAL PARAMETERS IN GROUNDWATER SAMPLES[a] COLLECTED FROM RCRA ROUND 1 TO ROUND 6 SAMPLING

Chemical Parameter	Background Average	Background Range	Background Frequency of Detection	Average	Monitoring Results Range	Frequency of Detection
			Perched Groundwater			
Chloride (mg/ℓ)[b]	102	91 - 110	6/6	138	1 U[c] - 1030	29/30
C.O.D.[d]	7.8	10 U - 16	2/6	19	10 U - 50	21/30
Conductivity (umhos/cm)[e]	1009	880 - 1120	6/6	1602	510 - 5310	30/30
Cyanide (mg/ℓ)	0.003	0.005 U - 0.005 U	0/6	0.003	0.005 U - 0.011	5/30
Fluoride (mg/ℓ)	1.1	0.76 - 1.6	6/6	0.52	0.17 - 1.8	30/30
Nitrate as Nitrogen (mg/ℓ)	0.015	0.02 U - 0.03	2/6	1.89	0.02 U - 11.2	22/30
pH Value	7.70	7.48 - 7.81	6/6	7.02	6.58 - 7.81	30/30
Phosphorus (mg/ℓ)	0.053	0.02 U - 0.2	3/6	0.19	0.02 U - 1.15	29/30
Sulfate (mg/ℓ)	16	1 U - 68	5/6	374	30 - 1320	30/30
T.D.S.[f] (mg/ℓ)	657	620 - 716	6/6	1363	320 - 3570	30/30
			Sand and Gravel Aquifer Groundwater			
Chloride (mg/ℓ)	33	28 - 40	6/6	28	2 - 89	201/201
C.O.D. (mg/ℓ)	8	10 U - 23	1/6	8.4	10 U - 144	35/201
Conductivity (umhos/cm)	643	590 - 690	6/6	733	300 - 2750	201/201
Cyanide (mg/ℓ)	0.003	0.005 U - 0.005 U	0/6	0.003	0.002 U - 0.013	8/201
Fluoride (mg/ℓ)	0.22	0.17 - 0.29	6/6	0.49	0.02 - 49	201/201
Nitrate as Nitrogen (mg/ℓ)	2.55	1.93 - 3.4	6/6	9.4	0.003 - 160	135/201
pH Value	7.39	7.24 - 7.57	6/6	7.38	6.83 - 8.29	201/201
Phosphorus (mg/ℓ)	0.012	0.02 U - 0.04 U	0/6	0.055	0.002 U - 1.04	76/201
Sulfate (mg/ℓ)	74	68 - 78	6/6	99	1 U - 780	200/201
T.D.S. (mg/ℓ)	458	400 - 531	6/6	544	188 - 2730	200/200

See footnotes at end of table

TABLE 4-49
(continued)

[a]Data can be found in RCRA Round 1 to Round 6 Reports, Dames and Moore, 1985a; 1985b; 1986; 1987a; 1987b; 1988.
[b](mg/ℓ) = milligrams per liter.
[c]U = below the indicated detection limit.
[d]C.O.D. = Chemical oxygen demand.
[e](umhos/cm) = micromhos per centimeter.
[f]T.D.S. = Total dissolved solid.

Great Miami Aquifer Groundwater

The pH values and cyanide and chloride concentrations in samples from the Great Miami Aquifer were less than the SMCL or MCL. Although not exceeding the 250 mg/ℓ SMCL, chloride concentrations in samples from Wells 3010 and 3013, ranging from 61 to 86 mg/ℓ, are consistently greater than the background values (Table 4-49). CODs above 20 mg/ℓ were sporadically found in samples from several wells, i.e., Wells 2014, 2015, 2018, 2061, 3016, 3013, 3020, and 4001. The CODs analyzed from the other samples were generally less than or close to the detection limit of 10 mg/ℓ.

A fluoride concentration greater than the 2 mg/ℓ SMCL was found only in one sample collected from Well 3019 during Round 4 RCRA sampling. However, this result may be erratic, since fluoride concentrations in the other samples from this well ranged from 0.08 to 0.14 mg/ℓ. Phosphorous concentrations in samples from 2000, 3000, and 4000 Series wells varied from one round to the other. Phosphorus was detected in about a third of these samples but in none of the background samples.

Nitrate nitrogen concentrations greater than the 10 mg/ℓ MCL were consistently found in samples collected from four wells, i.e., Wells 2019, 2021, 2022, and 3010. Nitrate nitrogen concentrations in these samples ranged from 25 to 160 mg/ℓ. These wells are all located in the waste pit area.

Anomalous conductivities, sulfate, and TDS were found in samples from several wells. Conductivities and TDS in samples from Wells 2021, 2022, 3010, 3013, and 3019 were greater than background (Table 4-49). Conductivities in samples from these wells ranged from 908 to 2,750 µmhos/cm. In addition to these five wells, TDS exceeding the 500 mg/ℓ SMCL was also found in samples from Wells 2017, 2019, and 4101. Average TDS in these samples ranged from 424 to 2730 mg/ℓ, while the background TDS ranged from 400 to 531 mg/ℓ. Average sulfate concentrations in samples from Wells 3010, 3013, and 3019 ranged from 273 to 557 mg/ℓ, greater than the 250 mg/ℓ SMCL or background (Table 4-49).

4.1.4.3.4 Organic Compounds

VOCs, semivolatile base/neutral and acid (BNAs) organic compounds, pesticides, coliform, TOC, and TOX were analyzed in groundwater samples collected from selected wells during various rounds of RCRA sampling. Perched zones and the Great Miami Aquifer are discussed separately below.

Perched Groundwater

The average coliform count was 4 per 100 mℓ in background samples from Well 1012, while they ranged from 64 to 2857 per 100 mℓ in samples from the other 1000 Series wells. High coliform counts were inconsistently found in Wells 1020, 1021, and 1022 in the waste pit area, and Well 1060, south of the southern boundary of the FEMP. Coliform counts in these wells varied dramatically from one round to the other, and the source of the coliform found in these wells is not conclusive.

Phenol concentrations in perched groundwater samples are very similar to the background values, which ranged from less than the 0.005 mg/ℓ detection to 0.02 mg/ℓ. A number of other organic compounds were also detected in samples collected from Wells 1012, 1019, 1020, 1022, and 1060 (Table 4-50).

TOC, ranging from less than the 1 mg/ℓ detection limit to 7 mg/ℓ, in perched groundwater samples was generally greater than the average background value of 0.65 mg/ℓ. Average TOC, ranging from 2.54 to 5.67 mg/ℓ in samples from Wells 1019, 1020, 1021, and 1022, was significantly greater than the background value of 0.65 mg/ℓ.

Among the samples collected from the background well, Well 1012, TOX above the 0.01 mg/ℓ detection limit was detected only during Round 3, at 8.27 mg/ℓ. This result may not be reliable, as the other four showed concentrations of less than the detection limit. TOX in samples from Well 1019 was generally higher, with an average of 0.127 mg/ℓ.

Great Miami Aquifer Groundwater

The average coliform count was 19 per 100 mℓ in background samples from Collector Well 2 with a range of 1 to 23,338 per 100 mℓ in samples from the other sand and gravel aquifer wells. High coliform counts were inconsistently found in samples from many wells. Coliform counts in these wells varied dramatically from one round to the other. The source of the coliform found in these wells is not certain.

Low concentrations of phenol were detected in many groundwater samples. Phenol was found at concentrations above the 0.005 mg/ℓ detection limit in 81 samples out of the 201 samples collected, ranging from 0.004 to 0.066 mg/ℓ. TOC ranged from 0.5 to 8.75 mg/ℓ, but was not found above the 1 mg/ℓ detection limit in samples from the background well. However, elevated TOC was not detected consistently in samples from any sand and gravel aquifer well.

Other organic compounds detected in samples from sand and gravel aquifer monitoring wells are included in Table 4-50. Among these wells, 16 volatile organic compounds were detected in samples collected from Well 3019, which is located in the waste pit area, with concentrations ranging from 10.5 to 4000 µg/ℓ. Some of these volatile organic compounds were also detected in the other wells located in the waste pit area, i.e., Wells 2004, 2011, 2019, 2021, 3008, 4001, and 4008. Organic compounds were also detected in many wells located in the vicinity of the South Field and to the south of the FEMP property, i.e., Wells 2015, 2016, 2017, 2060, 2061, 3014, 3016, and 3017.

4.1.4.4 Ongoing RI/FS and RCRA Groundwater Monitoring Programs

This section addresses the groundwater quality of the glacial overburden perched zones and the Great Miami Aquifer based on the results of samples collected from RI/FS and RCRA Groundwater

TABLE 4-50
ORGANIC COMPOUNDS DETECTED IN GROUNDWATER SAMPLES[a]
COLLECTED FROM ROUND 1 TO ROUND 6 RCRA SAMPLING

Perched Groundwater

- Monitoring Well 1012
  - Acetone - 84.4, 694 µg/ℓ[b]
  - Benzene - 14.8 µg/ℓ
  - Xylenes - 11.8 µg/ℓ
  - Cyclohexane - 15.0, 10.2 µg/ℓ

- Monitoring Well 1019
  - Bromoform - 7, 0.91[c] µg/ℓ
  - Chloroethene - 0.8, 0.87[c] µg/ℓ
  - 1,2-Dichlorobenzene - 0.83[c] µg/ℓ
  - 1,1-Dichloroethane - 3.4, 17.1, 1.0, 15.5, 15.0[c] µg/ℓ
  - cis-1,2-Dichloroethene - 5.1, 25.8, 29.50[c] µg/ℓ
  - Methylene chloride - trace
  - 1,1,2,2-Tetrachloroethane - 1.54[c] µg/ℓ
  - Tetrachloroethene - 8.2 µg/ℓ
  - Trichloroethene - 0.5 µg/ℓ

- Monitoring Well 1020
  - 1,1,1-Trichloroethane - 16.1 µg/ℓ

- Monitoring Well 1022
  - Acetone - 4770, 73 µg/ℓ
  - 2-Propanol - 8500, 21.5 µg/ℓ

- Monitoring Well 1060
  - Acetone - 4480, 88 µg/ℓ
  - 2-Propanol - 1420 µg/ℓ

Sand and Gravel Aquifer Groundwater

- Collector Well 2
  - Acetone - 30.8 µg/ℓ
  - Cyclohexane - 12.0 µg/ℓ

See foonotes at end of table

TABLE 4-50
(continued)

- Monitoring Well 2004
  - Acetone - 580 µg/ℓ
  - Cyclohexane - 600 µg/ℓ
  - Phenols - 0.006 µg/ℓ
  - Trichloroethene - 0.0044 µg/ℓ

- Monitoring Well 2011
  - Carbon disulfide - 6.3 µg/ℓ
  - Butanol - 195 µg/ℓ

- Monitoring Well 2013
  - Acetone - 735, 1,800 µg/ℓ
  - Cyclohexane - 300 µg/ℓ
  - 2-Propanol - 29,600 µg/ℓ

- Monitoring Well 2015
  - Acetone - 120, 104 µg/ℓ
  - Cyclohexane - 20.0 µg/ℓ
  - 1,1-Dichloroethane - 1.1, 2.3 µg/ℓ
  - 1,1,1-Trichloroethane - 0.0051, 2.9, 7, 18.9, 5.13[c] µg/ℓ
  - Trichloroethene - 3.7 µg/ℓ

- Monitoring Well 2016
  - Acetone - 930 µg/ℓ

- Monitoring Well 2017
  - Acetone - 17,700 µg/ℓ
  - 2-Propanol - 45,000 µg/ℓ

- Monitoring Well 2018
  - Acetone - 24,500 µg/ℓ
  - Cyclohexane - 900 µg/ℓ

See foonotes at end of table

TABLE 4-50
(continued)

- Monitoring Well 2019
  - 1,1,1-Trichloroethane - 8.6 µg/ℓ

- Monitoring Well 2021
  - Tetrachloroethene - 11.9 µg/ℓ
  - 1,1,1-Trichloroethane - 10.5 µg/ℓ

- Monitoring Well 2060
  - Acetone - 34.2 µg/ℓ
  - 1,1,1-Trichloroethane - 8.7, 2.0 µg/ℓ

- Monitoring Well 2061
  - Acetone - 40.5 µg/ℓ
  - Cyclohexane - 42, 12.5 µg/ℓ
  - 1,1,1-Trichloroethane - 87 µg/∫

- Monitoring Well 3008
  - Acetone - 40 µg/ℓ
  - Cyclohexane - 22 µg/ℓ
  - 2,4-D - 4.06 µg/ℓ
  - 2,3,5-TP (Silvex) - 0.694 µg/ℓ
  - 1,1,1,-Trichloroethane - 6 µg/ℓ

- Monitoring Well 3009
  - Acetone - 12, 8,670, 29.8 µg/ℓ
  - Cyclohexane - 10.2 µg/ℓ
  - 2-Propanol - 4,000, 26,400 µg/ℓ

- Monitoring Well 3010
  - Acetone - 10,000 µg/ℓ
  - Cyclohexane - 5,000 µg/ℓ
  - Trichloroethene - 1.7 µg/ℓ

See foonotes at end of table

TABLE 4-50
(continued)

- Monitoring Well 3013
  - Acetone - 1030, 34.2 µg/ℓ

- Monitoring Well 3014
  - Bromoform - 2.4 µg/ℓ
  - Tetrachloroethene - 1.1 µg/ℓ
  - Trichloroethene - 1.0 µg/ℓ

- Monitoring Well 3016
  - Acetone - 40.8 µg/ℓ
  - Cyclohexane - 60.0 µg/ℓ

- Monitoring Well 3017
  - Acetone - 58.5, 1,040 µg/ℓ
  - Cyclohexane - 5,000 µg/ℓ
  - 2-Propanol - 578, 130 µg/ℓ

- Monitoring Well 3019
  - Acetone - 490 µg/ℓ
  - Benzene - 18.5 µg/ℓ
  - Bromodichloromethane - 22.0 µg/ℓ
  - Bromoform - 34.1 µg/ℓ
  - Carbon tetrachloride - 10.5 µg/ℓ
  - Chloroform - 41.6 µg/ℓ
  - Dibromochloromethane - 14.6 µg/ℓ
  - 1,2-Dichloroethane - 29.3 µg/ℓ
  - 1,1-Dichloroethene - 22.9 µg/ℓ
  - trans-1,2-Dichloroethene - 37.6 µg/ℓ
  - 2-Propanol - 4000, 830 µg/ℓ
  - Tetrachloroethene - 36.3 µg/ℓ
  - Toluene - 28.5 µg/ℓ
  - 1,1,1-Trichloroethane - 27.5 µg/ℓ
  - Trichloroethene - 58.1 µg/ℓ
  - Trichlorofluoromethane - 15.7 µg/ℓ

See foonotes at end of table

TABLE 4-50
(continued)

- Monitoring Well 3020
  - Acetone - 3,600 μg/ℓ
  - 2-Propanol - 8,390 μg/ℓ

- Monitoring Well 4001
  - Acetone - 15.6 μg/ℓ
  - Cyclohexane - 20.0 μg/ℓ
  - 1,1,1-Trichloroethane - 2 μg/ℓ

- Monitoring Well 4008
  - Acetone - 21.3 μg/ℓ
  - Butanol - 180.0 μg/ℓ
  - Carbon disulfide - 32.3 μg/ℓ
  - Cyclohexane - 12.0 μg/ℓ

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[a]Data can be found in RCRA Round 1 to Round 6 Reports, Dames and Moore, 1985a; 1985b, 1986; 1987a; 1987b; 1988. It is noted that QA/QC procedures used for Rounds 1 to 5 were inconsistent with the subsequently approved RI/FS QAPP. Most data listed in this table were resulted from Round 1 to Round 5 sampling, unless otherwise indicated.
[b]μg/ℓ = micrograms per liter.
[c]Resulted from Round 6 sampling.

See foonotes at end of table

Assessment sampling programs. Data that were available as of December 1, 1991 in the Fernald Database, which include samples collected from May 1988 to August 1991, are used as the basis of the following discussion. Parameters analyzed for in these samples include radiological constituents, metals, general chemical parameters, and organic compounds.

Groundwater quality in the vicinity of the FEMP was statistically compared to background water quality, which was established based on chemical characteristics identified in selected background monitoring wells. Background wells were selected to reflect groundwater quality not influenced by operations at the FEMP. An upper tolerance limit (UTL) was calculated for each constituent detected in the background water samples. Groundwater quality observed from the other monitoring wells or piezometers are then compared to the UTL for each constituent. The strategies of background well selection are different between perched zones and sand and gravel aquifer monitoring, and are addressed separately. The statistical analysis followed the methods outlined in the Risk Assessment Work Plan Addendum (DOE 1992a). Since the hydrogeological settings of the perched groundwater zones are very different from the Great Miami Aquifer, discussions of groundwater quality in these two hydrogeological systems are presented separately in this section.

4.1.4.4.1 Perched Groundwater Quality

Since perched groundwater zones are isolated and are not completely interconnected in the vicinity of the FEMP, groundwater defined as upgradient may not be absolutely suitable to establish background water quality. Thus, wells that are considered to produce typical water quality for perched groundwater were selected as background wells. As such, Monitoring Wells 1024, 1052, 1059, 1060, and 1065 are designated as background wells for glacial overburden groundwater. These wells are located in areas that are not likely to have been impacted by FEMP activities. Radiological and nonradiological constituents detected in samples from these wells are summarized in Appendix M, Tables M-1 and M-2, respectively. Locations of 1000 Series perched zone monitoring wells and piezometers are illustrated in Figures 3-26, and 3-30 to 3-32, respectively.

Radiological constituents detected in background samples include radium-228, thorium-228 and -230, uranium-234 and -238, total thorium, and total uranium. With the exception of uranium species, detections of these constituents were inconsistent and their concentrations were low. Total uranium has the highest frequency of detection, 19 of 27 samples. Uranium concentrations in these samples ranged from 0.8 to 11 μg/ℓ.

Calcium is the dominant cation constituent in background samples, followed by magnesium, sodium, and potassium. Average concentrations of these constituents in background samples are 98.9, 35.7, 23.1, and 6.8 mg/ℓ, respectively. Sulfate is the dominant anion constituent in background perched groundwater, followed by chloride and fluoride. Average concentrations of these constituents are 72.9, 8.81, and 0.71 mg/ℓ, respectively. Organic compounds present in background water samples include

acetone, carbon disulfide, methylene chloride, n-nitrosodiphenylamine, and phenols. Detections of acetone and methylene chloride in background samples were most likely related to laboratory contamination, since they are common laboratory contaminants and the detections were either below the detection limits or were associated with a laboratory method blank detection. With the exception of these two compounds, concentrations of organic compounds detected in background samples ranged from 0.002 to 0.04 mg/ℓ.

Radiological Constituents

Uranium is the most widespread contaminant in the perched groundwater. Wells containing total uranium and uranium isotopes above the UTLs and their average concentration ranges are listed in Table 4-51. Isotopic uranium data are used to examine uranium isotopic ratios in groundwater. Among the four isotopes, uranium-234 and -238 dominate the perched groundwater at the FEMP. The observed U-238/U-234 ratios in the majority of the perched groundwater samples that showed elevated uranium concentrations are generally greater than one. This is usually an indication of deviation from naturally-occurring source related contamination.

The UTL of total uranium calculated from background samples is 0.006 mg/ℓ. Average concentrations of total uranium in groundwater sampled from the piezometers located in the former production area ranged from 0.007 to 568 mg/ℓ. The maximum concentrations were found in samples collected from Well 1324, which is located in the Plant 9 area. A large area with total uranium concentrations of above 1 mg/ℓ was observed in perched groundwater beneath the Plant 2/3, Plant 6, and Plant 8 areas, which are all located in the southern half of the former production area.

Elevated average total uranium concentrations in shallow groundwater samples collected from the waste storage area ranged from 0.007 to 11.5 mg/ℓ. Groundwater collected from two wells located southwest of the former production area, Wells 1020 and 1523, also contained uranium, at 0.061 and 0.017 mg/ℓ, respectively.

Samples collected from all of the eight piezometers located in the fire training area showed elevated total uranium concentrations ranging from 0.014 to 0.117 mg/ℓ. A water sample collected from the oil-fire pond during May 1990 revealed the highest total uranium concentration found in any water sample from the area. Groundwater samples were collected from all six wells located in the vicinity of the sewage treatment plant, Wells 1441 to 1444, 1447, and 1448. Average total uranium concentrations in these wells ranged from 0.013 to 3.23 mg/ℓ. Uranium-contaminated perched groundwater was also present in wells located in the vicinity of the South Field, i.e., Wells 1045, 1046, 1047, 1048, 1516, and 1517, and a well situated west of Paddys Run along the southwestern boundary of the FEMP, Well 1518.

TABLE 4-51
WELLS WITH ELEVATED CONCENTRATIONS OF[a]
TOTAL URANIUM, URANIUM ISOTOPES, AND TOTAL THORIUM
FROM ONGOING RI/FS AND RCRA SAMPLING

Constituent (UTL)[b]	Wells with Elevated Concentrations[c]	Average Concentration Range (pCi/ℓ)[d]
	Waste Storage Area	
Uranium-234 (2.89 pCi/ℓ)	1011, 1019, 1021, 1022, 1025, 1027, 1028, 1030, 1031, 1032, 1033, 1038, 1042, 1073, 1075, 1076, 1077, 1080, 1081, 1082, 1083, 1084, 1643, 1644	2.9 - 964
Uranium-235/236 (Detection Limit)[e]	1019, 1021, 1022, 1027, 1032, 1073, 1075, 1076, 1078, 1082, 1083, 1084, 1643, 1644	0.68 - 120
Uranium-238 (2.05 pCi/ℓ)	1008, 1011, 1019, 1021, 1022, 1025, 1027, 1028, 1030, 1031, 1032, 1033, 1034, 1038, 1042, 1073, 1074, 1075, 1076, 1077, 1078, 1080, 1081, 1082, 1083, 1084, 1643, 1644	2.11 - 4447
Total Uraium (0.006 mg/ℓ[f])	1008, 1011, 1019, 1021, 1022, 1025, 1027, 1028, 1031, 1032, 1033, 1034, 1035, 1042, 1073, 1075, 1076, 1077, 1078, 1081, 1082, 1083, 1084, 1644	0.007 - 11.5[g]
Total Thorium (0.003 mg/ℓ)	1008, 1010, 1021, 1022, 1025, 1039, 1074, 1081, 1084	0.004 - 0.034[g]
	Production Area	
Uranium-234 (2.89 pCi/ℓ)	1053, 1054, 1055, 1064, 1086, 1087, 1088, 1089, 1090, 1148, 1149, 1161, 1195, 1196, 1197, 1199, 1208, 1209, 1211, 1212, 1213, 1214, 1218, 1219, 1220, 1224, 1227, 1228, 1231, 1232, 1233, 1234, 1236, 1324, 1411, 1676	4.83 - 50553
Uranium-235/236 (Detection Limit)[e]	1053, 1054, 1086, 1089, 1148, 1149, 1161, 1195, 1196, 1197, 1199, 1208, 1209, 1211, 1212, 1213, 1214, 1218, 1219, 1220, 1224, 1227, 1228, 1231, 1232, 1233, 1234, 1236, 1324, 1411	0.65 - 7494
Uranium-238 (2.05 pCi/ℓ)	1041, 1053, 1054, 1055, 1064, 1086, 1087, 1088, 1089, 1090, 1148, 1149, 1161, 1195, 1196, 1197, 1199, 1208, 1209, 1211, 1212, 1213, 1214, 1218, 1219, 1220, 1224, 1227, 1228, 1231, 1232, 1233, 1234, 1236, 1324, 1411, 1676	2.15 - 59924

See footnotes at end of table

3577

TABLE 4-51
(continued)

Constituent (UTL)[b]	Wells with Elevated Concentrations[c]	Average Concentration Range (pCi/ℓ)[d]
	Production Area (cont.)	
Total Uraium (0.006 mg/ℓ[f])	1041, 1053, 1054, 1055, 1064, 1086, 1087, 1088, 1089, 1090, 1110, 1111, 1112, 1113, 1117, 1130, 1131, 1134, 1135, 1136, 1145, 1148, 1149, 1151, 1152, 1153, 1154, 1155, 1156, 1157, 1158, 1160, 1161, 1167, 1171, 1172, 1173, 1174, 1177, 1178, 1179, 1180, 1181, 1182, 1183, 1185, 1186, 1187, 1188, 1189, 1190, 1193, 1194, 1195, 1196, 1197, 1199, 1200, 1201, 1202, 1203, 1204, 1205, 1206, 1207, 1208, 1209, 1210, 1211, 1212, 1213, 1214, 1215, 1216, 1217, 1218, 1219, 1220, 1221, 1223, 1224, 1225, 1226, 1227, 1228, 1229, 1230, 1231, 1232, 1233, 1234, 1236, 1237, 1239, 1240, 1241, 1242, 1243, 1244, 1245, 1246, 1250, 1253, 1255, 1258, 1259, 1262, 1263, 1266, 1267, 1268, 1269, 1270, 1271, 1272, 1273, 1274, 1276, 1277, 1279, 1280, 1281, 1283, 1287, 1291, 1293, 1299, 1301, 1304, 1317, 1324, 1332, 1336, 1337, 1338, 1339, 1340, 1341, 1342, 1343, 1344, 1346, 1347, 1348, 1350, 1351, 1352, 1353, 1354, 1356, 1357, 1358, 1359, 1360, 1361, 1362, 1363, 1403, 1411, 1412, 1418, 1420, 1423, 1676	0.007 - 568[g]
Total Thorium (0.003 mg/ℓ)	1053, 1054, 1055, 1148, 1149, 1153, 1157, 1161, 1197, 1199, 1208, 1209, 1212, 1213, 1220, 1231, 1232, 1234, 1324, 1411	0.005 - 0.37[g]
	Sewage Treatment Plant	
Uranium-234 (2.89 pCi/ℓ)	1442, 1443, 1444, 1447, 1448	5.28 - 207
Uranium-235/236 (Detection Limit)[e]	1442, 1443, 1447, 1448	0.706 - 14.5
Uranium-238 (2.05 pCi/ℓ)	1442, 1443, 1444, 1447, 1448	4.28 - 219
Total Uraium (0.006 mg/ℓ[f])	1441, 1442, 1443, 1444, 1447, 1448	0.013 - 3.23[g]
Total Thorium (0.003 mg/ℓ)	1443, 1447	0.011 - 0.021[g]

See footnotes at end of table

TABLE 4-51
(continued)

Constituent (UTL)[b]	Wells with Elevated Concentrations[c]	Average Concentration Range (pCi/ℓ)[d]
	Fire Training Area	
Uranium-234 (2.89 pCi/ℓ)	1508, 1509, 1510, 1511, 1512, 1513, 1514, 1515	2.94 - 47.1
Uranium-235/236 (Detection Limit)[e]	1508, 1509, 1510, 1511	1.2 - 3.7
Uranium-238 (2.05 pCi/ℓ)	1508, 1509, 1510, 1511, 1512, 1513, 1514, 1515	2.71 - 45.3
Total Uraium (0.006 mg/ℓ[f])	1508, 1509, 1510, 1511, 1512, 1513, 1514, 1515	0.014 - 0.117[g]
Total Thorium (0.003 mg/ℓ)	1508, 1509, 1510, 1512, 1513	0.004 - 0.026[g]
	Other Areas	
Uranium-234 (2.89 pCi/ℓ)	1020, 1046, 1047, 1048, 1124	3.05 - 14.5
Uranium-235/236 (Detection Limit)[e]	1020, 1046	0.7 - 1.3
Uranium-238 (2.05 pCi/ℓ)	1020, 1045, 1046, 1047, 1048, 1124	2.15 - 20.6
Total Uraium (0.006 mg/ℓ[f])	1020, 1045, 1046, 1047, 1048, 1124, 1516, 1517, 1518, 1523	0.008 - 0.49[g]
Total Thorium (0.003 mg/ℓ)	1047, 1048, 1517	0.004 - 0.006[g]

[a]Based on data available in the Fernald Database as of December 1, 1991.
[b](UTL) = upper tolerance limit.
[c]Wells listed contain concentrations of the constituent that are above the UTL.
[d](pCi/ℓ) = picoCuries per liter.
[e]Uranium-235/236 was not detected in any background sample.
[f](mg/ℓ) = milligrams per liter.
[g]The unit is in mg/ℓ.

Most detections of radium isotopes, technetium-99, and thorium isotopes in perched groundwater samples were low level and were not recurrent in most of the wells. As shown in Table 4-52, among the samples collected from 1000 Series wells, repeated detections of one or more of these constituents occurred only in 31 wells. In addition to these wells, these radionuclides were also detected in the only sample collected from each of the thirty-one 1000 Series Wells as shown in Table 4-52. The majority of these 62 wells are located in the former production area and the waste storage area. Perched groundwater samples collected from piezometers located in the vicinity of the fire training area showed detections of radium-226 and thorium isotopes. Concentrations of these constituents detected in these wells ranged from 1.21 to 5.93 pCi/ℓ. Groundwater samples collected from the wells located in the vicinity of the sewage treatment plant showed detections of radium-226, technetium-99, and thorium isotopes. Samples from Well 1046, which is located north of the South Field, also contained repeated detections of thorium-228 and thorium-230 with concentrations ranging from 1.1 to 7.8 pCi/ℓ. At Well 1020, located southwest of the former production area, radium-226, thorium-228, and thorium-230 were detected with average concentrations of 1.125, 0.88, and 0.734 pCi/ℓ, respectively. The source of these detections can not be stated conclusively.

Total thorium was detected only once, at 0.003 mg/ℓ, out of the 13 samples from the background wells. Average concentrations of total thorium in the other 1000 Series wells ranged from less than the detection limit to 0.37 mg/ℓ. Wells containing average total thorium concentrations above 0.003 mg/ℓ and their concentration ranges are stated in Table 4-51. As with the radiological constituents discussed previously, samples from 1000 Series wells in the vicinity of the waste storage area, the former production area, the sewage treatment plant, the fire training area, and the South Field contained total thorium concentrations that were above the level of the only detection in background samples.

Cesium-137, plutonium isotopes, and ruthenium-106 were not detected in any RI/FS and RCRA samples. Neptunium-237 and uranium-235 were respectively detected in one sample from Wells 1035 and 1032. Detections of strontium-90 in perched groundwater were sporadic and inconsistent. However, strontium-90 was detected in the only sample collected from Wells 1221, 1411, and 1643 with concentration ranging from 5.35 to 15.9 pCi/ℓ (Table 4-52). Wells 1221 and 1411 are located in the former production area, and Well 1643 is located in the waste pit area.

Metals

Metals detected in perched groundwater are summarized in Table M-5 of Appendix M. Twenty-one metals were detected in background perched groundwater under the ongoing RI/FS and RCRA sampling (Table 4-53). Arsenic, cobalt, and molybdenum were only detected once among these samples. The concentrations of these single detections were used as the UTLs. Wells containing average metal concentrations above these UTLs and their average concentration ranges are listed in Table 4-54.

TABLE 4-52
DETECTIONS OF RADIOLOGICAL CONSTITUENTS IN PERCHED GROUNDWATER[a] FROM ONGOING RI/FS AND RCRA SAMPLING

Constituent	Concentration Range (pCi/ℓ)[b]	Wells with Repeated Detections	Wells with Detection in the Only Sample[c]
		Waste Storage Area	
Radium-226	1.1 - 7.3	1031, 1073, 1075	1644
Radium-228	1.88	NA[d]	1644
Strontium-90	15.9	NA	1643
Technetium-99	30 - 2805	1025, 1073, 1075, 1083	NA
Thorium-228	1.1 - 4.0	1022, 1035, 1073, 1076, 1081, 1082, 1084	NA
Thorium-230	1.3 - 23.3	1021, 1022, 1035, 1073, 1074, 1075, 1076, 1077, 1082, 1084	1644
Thorium-232	1.1 - 23.1	1021, 1022, 1073, 1084	NA
		Production Area	
Radium-226	1.0 - 7.3	1053, 1212, 1213	1086, 1199, 1209, 1211, 1219, 1220, 1221, 1227, 1234, 1236, 1411
Radium-228	0.9 - 219.0	1149, 1161	1148, 1209, 1221, 1411
Strontium-90	5.4 - 6.8	NA	1221, 1411
Technetium-99	51 - 13230	1148, 1149, 1212, 1231, 1232, 1233, 1324, 1442	1195, 1196, 1197, 1199, 1208, 1209, 1211, 1214, 1219, 1220, 1221, 1227, 1228, 1234, 1236
Thorium-228	1.0 - 49.7	1041, 1055, 1149, 1232	1088, 1089, 1197, 1199, 1208, 1209, 1211, 1227, 1324, 1411
Thorium-230	1.0 - 16.6	1041, 1148, 1149, 1232	1089, 1196, 1197, 1199, 1208, 1209, 1224, 1234, 1324, 1411
Thorium-232	1.0 - 40.8	1053, 1055, 1149, 1232	1089, 1199, 1208, 1209, 1220, 1324, 1411

See footnotes at end of table

TABLE 4-52
(continued)

Constituent	Concentration Range (pCi/ℓ)[b]	Wells with Repeated Detections	Wells with Detection in the Only Sample[c]
		Sewage Treatment Plant	
Radium-226	1.17 - 1.19	NA	1441, 1448
Technetium-99	385 - 3185	NA	1441, 1444, 1447
Thorium-228	1.8 - 4.2	1447	NA
Thorium-230	3.3 - 10.5	1447	NA
Thorium-232	1.3 - 3.3	1447	NA
		Fire Training Area	
Radium-226	3.4 - 5.9	NA	1508, 1510
Thorium-228	1.3 - 3.4	NA	1508, 1513
Thorium-230	1.2 - 3.4	NA	1508, 1509, 1510, 1514
Thorium-232	1.3 - 2.8	NA	1508, 1510
		Other Areas	
Radium-226	1.6 - 1.9	1020	NA
Thorium-228	1.1 - 1.8	1020, 1046	NA
Thorium-230	1.1 - 7.8	1020, 1046	NA

[a]Excluding total thorium, uranium isotopes, and total uranium.
[b](pCi/ℓ) = picoCuries per liter.
[c]Only one sample was collected from these wells for the analysis of the specific constituent.
[d]NA = Not applicable.

TABLE 4-53

UPPER TOLERANCE LIMITS OF METALS DETECTED IN BACKGROUND PERCHED GROUNDWATER SAMPLES ONGOING RI/FS AND RCRA SAMPLING

Metal	Upper Tolerance Limit (mg/ℓ)
Aluminum	0.720 mg/ℓ
Arsenic	0.003 mg/ℓ
Barium	0.132 mg/ℓ
Beryllium	0.004 mg/ℓ
Cadmium	0.009 mg/ℓ
Calcium	128.017 mg/ℓ
Chromium	0.076 mg/ℓ
Cobalt	0.013 mg/ℓ
Copper	0.046 mg/ℓ
Iron	1.81 mg/ℓ
Lead	0.054 mg/ℓ
Magnesium	56.792 mg/ℓ
Manganese	0.202 mg/ℓ
Mercury	0.001 mg/ℓ
Molybdenum	0.020 mg/ℓ
Nickel	0.103 mg/ℓ
Potassium	25.931 mg/ℓ
Silver	0.050 mg/ℓ
Sodium	59.615 mg/ℓ
Vanadium	0.058 mg/ℓ
Zinc	0.064 mg/ℓ

TABLE 4-54
1000 SERIES WELLS WITH ELEVATED METAL CONCENTRATIONS[a] FROM ONGOING RI/FS AND RCRA SAMPLING

Metal	Wells with Elevated Concentrations[b]	Average Concentration Range (mg/ℓ)[c]
	Waste Storage Area	
Aluminum	1081, 1083	0.74 - 1.18
Antimony[d]	1021	0.002
Arsenic[e]	1008, 1010, 1011, 1019, 1024, 1035, 1078, 1080	0.007 - 0.113
Barium	1008, 1011, 1019, 1021, 1029, 1031, 1039, 1042, 1073, 1075, 1078, 1081, 1083	0.136 - 0.368
Beryllium	1081, 1083	0.016 - 0.027
Cadmium	1025, 1073, 1075	0.01 - 0.014
Calcium	1010, 1011, 1019, 1022, 1025, 1028, 1030, 1031, 1032, 1038, 1039, 1073, 1075, 1078, 1079, 1081, 1082, 1083, 1084	128 - 1680
Chromium	1075	0.084
Cobalt[e]	1028, 1081, 1083	0.017 - 0.245
Iron	1011, 1075	4.19 - 11.2
Magnesium	1011, 1019, 1022, 1025, 1028, 1030, 1032, 1038, 1039, 1073, 1074, 1075, 1076, 1078, 1079, 1080, 1081, 1082, 1084	58 - 659
Manganese	1008, 1011, 1019, 1020, 1021, 1022, 1025, 1038, 1039, 1073, 1075, 1076, 1077, 1078	0.214 - 35.4
Mercury	1073	7.55
Molybdenum[e]	1008, 1031, 1038, 1042, 1073, 1075, 1082, 1084	0.023 - 0.607
Nickel	1030, 1074, 1075	0.136 - 0.271
Osmium[d]	1025, 1031, 1074	0.059 - 0.469
Potassium	1031, 1075	93 - 229
Selenium[d]	1010, 1021, 1029, 1031, 1032, 1034, 1076, 1079, 1081, 1082	0.002 - 0.058
Silver	1022, 1077	0.053 - 0.089
Sodium	1019, 1025, 1031, 1032, 1039, 1073, 1075, 1081	95 - 1094
Thallium[d]	1019	0.001
Vanadium	1028, 1081, 1083	0.061 - 0.275
Zinc	1025, 1081, 1083	0.113 - 0.259
	Production Area	
Aluminum	1149, 1186, 1199, 1324, 1675	0.768 - 8.37

See footnotes at end of table

TABLE 4-54
(continued)

Metal	Wells with Elevated Concentrations[b]	Average Concentration Range (mg/ℓ)[c]
Antimony[d]	1085, 1087, 1088, 1149, 1186, 1199, 1208, 1209, 1212, 1213, 1287, 1324, 1423, 1675, 1676	0.0004 - 0.297
Barium	1041, 1149, 1208, 1213, 1324, 1411	0.135 - 0.589
Beryllium	1149, 1186, 1199, 1209, 1324, 1423	0.005 - 0.072
Cadmium	1149, 1186, 1199, 1212, 1283, 1324, 1423, 1675	0.01 - 0.04
Calcium	1041, 1089, 1149, 1186, 1193, 1199, 1208, 1212, 1246, 1250, 1283, 1287, 1324, 1423, 1675, 1676	138 - 976
Chromium	1149, 1186, 1199, 1208, 1209, 1212, 1213, 1324, 1423	0.1 - 2.11
Cobalt[e]	1149, 1186, 1199, 1208, 1209, 1212, 1213, 1324, 1423, 1675	0.014 - 0.205
Copper	1149, 1186, 1324	0.059 - 0.384
Iron	1411, 1675	2.65 - 4.6
Lead	1064	0.059
Magnesium	1041, 1053, 1064, 1087, 1089, 1149, 1199, 1283, 1287, 1363, 1423, 1675, 1676	58 - 251
Manganese	1041, 1085, 1086, 1087, 1089, 1149, 1182, 1193, 1199, 1203, 1208, 1212, 1213, 1283, 1287, 1324, 1411, 1412, 1423, 1675, 1676	0.205 - 1.93
Mercury	1183, 1212	0.002 - 0.004
Molybdenum[e]	1041, 1053, 1054, 1055, 1087, 1088, 1089, 1090, 1149, 1324, 1675, 1676	0.021 - 0.14
Nickel	1149, 1324	0.227 - 0.262
Selenium[d]	1055, 1250	0.002 - 0.011
Silicon[d]	1675, 1676	7.33 - 7.75
Silver	1149, 1186, 1199, 1324, 1423	0.073 - 0.824
Sodium	1149, 1324, 1423	79 - 207
Thallium[d]	1246, 1287, 1412	0.002 - 0.003
Vanadium	1149, 1186, 1199, 1324	0.081 - 0.67
Zinc	1149	0.268

See footnotes at end of table

TABLE 4-54
(continued)

Metal	Wells with Elevated Concentrations[b]	Average Concentration Range (mg/ℓ)[c]
	Sewage Treatment Plant	
Aluminum	1443	1.01
Calcium	1447	151
Manganese	1441, 1443	0.55 - 0.59
Sodium	1447	74
	Fire Training Area	
Aluminum	1511	0.84
Calcium	1509, 1512	136 - 155
Manganese	1508, 1509, 1511, 1512, 1515	0.21 - 2.54
	Other Areas	
Arsenic[e]	1040, 1058	0.058 - 0.069
Barium	1040, 1046, 1048, 1058	0.133 - 0.444
Calcium	1016, 1124	139 - 189
Copper	1059	0.055
Iron	1040, 1058	2.94 - 3.15
Seleneium[d]	1012, 1016, 1046, 1124	0.002 - 0.027
Sodium	1012	241

[a]Based on data available in the Fernald Database as of December 1, 1991.
[b]Wells listed contain concentrations of the constituent that are above the UTL.
[c](mg/ℓ) = milligrams per liter.
[d]This constituent was not detected in any background sample.
[e]This constituent has only been detected once in background samples.

As with the background samples, calcium is the dominant cation in perched groundwater from the other 1000 Series wells, followed by magnesium, sodium, and potassium. Although not reported in background samples, antimony, osmium, selenium, silicon, and thallium were detected in the other 1000 Series Wells. However, molybdenum was detected in background samples, but not detected in the other 1000 Series Wells. Detections of most trace or heavy metals were near the method detection limits or nonrecurrent. The majority of these nonrecurrent, low-level detections may be due to analytical uncertainty. However, occurrences of various metals in the waste storage area, former production area, sewage treatment plant, and fire training area may be associated with former production activities.

Above background concentrations of most metals were reported in a number of wells located in the waste storage area and the former production area (Table 4-54). In addition, groundwater samples from wells located in the South Field, Wells 1016, 1046, and 1058, contained above background concentrations of barium and/or calcium. Selenium was also detected in Wells 1016 and 1046. Samples from wells in the sewage treatment plant area contained elevated concentrations of aluminum, calcium, manganese, and sodium. Elevated concentrations of aluminum, calcium, and manganese were also found in various wells located in the fire training area. Samples from wells located northwest of the FEMP property, Wells 1040, 1058, and 1059, contained above background concentrations of arsenic, barium, copper, and iron that may not be related to the activities of the FEMP.

General Chemical Parameters

This section discusses anions, total Kjeldahl nitrogen (TKN), TOX, and total organic nitrogen (TON) in perched groundwater at the FEMP site. Although analyses of TKN, TOX, and TON are related to organic compounds, these parameters are included in this section to characterize general organic chemistry in groundwater samples. The UTLs for general chemical constituents detected in background samples were calculated and are listed as follows:

- Ammonia - 0.362 mg/ℓ
- Nitrate - 0.341 mg/ℓ
- TKN - 0.959 mg/ℓ
- TON - 0.403 mg/ℓ
- Chloride - 40.1 mg/ℓ
- Phosphorus - 0.488 mg/ℓ
- TOC - 13.0 mg/ℓ
- Fluoride - 1.62 mg/ℓ
- Sulfate - 211 mg/ℓ
- TOX - 0.066 mg/ℓ

Wells containing average concentrations of these parameters that exceeded the UTLs are listed in Table 4-55.

Although concentrations of general chemical constituents were quite variable, most of the maximum concentrations occurred in samples from wells located in the waste storage area (Table 4-55). Elevated concentrations of ammonia, chloride, fluoride, nitrate, phosphorus, sulfate, TKN, TOX, and TON were found in various wells located in the waste pit area. A sulfide concentration of 4.26 mg/ℓ was also detected in a sample from Well 1025 located south of Waste Pit 5. Elevated ammonia,

TABLE 4-55
1000 SERIES WELLS WITH ELEVATED GENERAL CHEMICAL CONCENTRATIONS[a] FROM ONGOING RI/FS AND RCRA SAMPLING

Parameter	Wells with Elevated Concentrations[b]	Average Concentration Range (mg/ℓ)[c]
	Waste Storage Area	
Ammonia	1031, 1073, 1075, 1076	0.507 - 189
Chloride	1019, 1021, 1025, 1028, 1031, 1032, 1039, 1042, 1073, 1074, 1075, 1078, 1083, 1643	44.3 - 6060
Cyanide[d]	1031	0.079
Fluoride	1021, 1073, 1075	1.68 - 6.02
Nitrate	1010, 1011, 1019, 1025, 1028, 1029, 1031, 1032, 1034, 1073, 1075, 1078, 1081, 1083	0.652 - 156
Phosphorus	1025, 1035, 1038, 1079, 1081, 1082, 1084	0.92 - 2.34
Sulfate	1019, 1021, 1022, 1025, 1028, 1032, 1073, 1075, 1079, 1081, 1082, 1084	245 - 1150
Sulfide[d]	1025	4.26
TKN[e]	1008, 1011, 1027, 1031, 1039, 1042, 1073, 1075, 1084	2.62 - 196
TOX[f]	1011, 1019, 1031, 1073, 1075	0.083 - 0.609
TON[g]	1008, 1010, 1011, 1022, 1035, 1042, 1073, 1075, 1078, 1082, 1083, 1084	0.44 - 21
	Production Area	
Ammonia	1053, 1149, 1643	1.02 - 2.5
Chloride	1041, 1149	51 - 289
Cyanide[d]	1149, 1199, 1208, 1209, 1212, 1213, 1246, 1324, 1675	0.002 - 0.248
Nitrate	1054, 1064, 1089, 1110, 1111, 1130, 1145, 1148, 1149, 1150, 1151, 1156, 1158, 1160, 1161, 1178, 1180, 1183, 1185, 1186, 1188, 1189, 1190, 1194, 1195, 1196, 1197, 1199, 1200, 1202, 1204, 1205, 1206, 1207, 1208, 1209, 1211, 1212, 1214, 1215, 1216, 1217, 1218, 1219, 1220, 1221, 1223, 1225, 1226, 1227, 1228, 1231, 1232, 1233, 1234, 1236, 1240, 1242, 1250, 1258, 1259, 1263, 1267, 1269, 1277, 1304, 1324, 1336, 1337, 1403, 1420, 1423, 1675, 1676	0.345 - 586
Phosphorus	1053, 1055, 1064, 1149	0.591 - 39.8
Sulfate	1055, 1064, 1085, 1089, 1643, 1675	213 - 345
TKN[e]	1041, 1053, 1064, 1149	1.89 - 8.45
	Production Area (cont.)	
TOC[h]	1031, 1149	13.5 - 39.9
TOX[f]	1149	0.652

See footnotes at end of table

TABLE 4-55
(continued)

Parameter	Wells with Elevated Concentrations[b]	Average Concentration Range (mg/ℓ)[c]
TON[g]	1053, 1054, 1055, 1064, 1089, 1149	0.58 - 5.1
	Sewage Treatment Plant	
Nitrate	1441, 1442, 1443, 1444, 1447	0.36 - 20
	Southfield Area	
Nitrate	1016, 1516, 1517	0.43 - 2.2
TKN[e]	1016	1.2
TOX[f]	1016	0.07
TON[g]	1016	0.55
	Other Areas	
Ammonia	1012, 1040, 1058	1.32 - 3.77
Chloride	1012, 1124	73.2 - 114
Nitrate	1012, 1020, 1124, 1518, 1523	0.55 - 2.02
TKN[e]	1012, 1040, 1058, 1124	0.98 - 4.27
TON[g]	1020, 1040, 1058	0.49 - 1.7

[a]Based on data available in the Fernald Database as of December 1, 1991.
[b]Wells listed contain concentrations of the parameter that are above the upper tolerance limit.
[c](mg/ℓ) = milligrams per liter.
[d]This constituent has not been detected in any background sample.
[e]TKN = total Kjeldahl nitrogen.
[f]TOX = total organic halides.
[g]TON = total organic nitrogen.
[h]TOC = total organic carbon.

chloride, nitrate, TKN, TOC, and TOX were reported in samples from Well 1031, located in the vicinity of the Clearwell. Cyanide was also detected in a sample from this well. Groundwater from Wells 1039, 1041, and 1042, which are located in the vicinity of the lime sludge ponds, contained elevated chloride, TKN, and/or TON. At Wells 1029, 1032, and 1034, which are located in the vicinity of Silos 1 and 2, groundwater had elevated nitrate concentrations. Elevated concentrations of chloride and sulfate were also found in samples from Well 1032.

The most common constituents detected above background in the former production area were nitrate, cyanide, TON, and sulfate (Table 4-55). Samples from wells located near the sewage treatment plant and the South Field also showed elevated concentrations of nitrate. Elevated concentrations of TKN, TOX, and TON were also reported in the South Field. Elevated concentrations of chloride, nitrate, and TKN were found in samples from Wells 1012 and 1124, which are located north and northeast of the former production area, respectively. Groundwater from Well 1012 also contained elevated concentrations of ammonia, ranging from 1.00 to 1.67 mg/ℓ. However, the different groundwater chemistry revealed by samples from these two wells may not be related to FEMP. Elevated concentrations of ammonia, TKN, and TON were found in samples from wells located northwest of the FEMP property, Wells 1040 and 1058. Again, these elevated concentrations may not be related to the FEMP.

Organic Compounds

Compared to background samples, a greater variety of organic compounds were detected in samples from the other 1000 Series wells (Table 4-56, Tables M-2 and M-4 of Appendix M). Only VOCs, semivolatile organic compounds, and a pesticide, heptachlor epoxide, were detected in these samples; PCBs were not found in any sample. Although found in samples from many wells, detections of acetone 2-butanone, and methylene chloride were generally low level and associated with detections in the method blanks.

As shown in Table 4-56, a variety of volatile and semivolatile organic compounds were detected in samples from Wells 1031 and 1643, which are located in the Clearwell and burn pit areas, respectively. Carbon disulfide, n-nitrosodiphenylamine, and phenol were detected in a sample collected from Well 1052 located in the area of the solid waste landfill. In addition to phenols, 33 other organic compounds were detected in samples from 1000 Series wells located in the waste storage area.

Samples from wells in the former production area also contained a variety of volatile and semivolatile organic compounds. Specific areas where organic compounds were detected include the vicinity of the Plant 6, the Plant 2/3, the Plant 9, the boiler plant, and the pilot plant. In addition to phenols, 27 volatile and semivolatile organic compounds were detected in these areas. A pesticide, heptachlor epoxide, was also detected in a sample from Well 1324, which is located in the vicinity of Plant 9.

TABLE 4-56
ORGANIC COMPOUNDS DETECTED IN 1000 SERIES WELLS[a]
DURING ONGOING RI/FS AND RCRA SAMPLING

Compound	Well Location	Concentrations (mg/ℓ)[b]
	Waste Storage Area	
Acetone	1019, 1024, 1025, 1027, 1028, 1031, 1038, 1052, 1073, 1074, 1075, 1076, 1078, 1079, 1080, 1081, 1082, 1083, 1643	0.002 - 0.029
Benzene	1031, 1643	0.003 - 0.005
Bromochloromethane	1010	0.050
2-Butanone	1031, 1643	0.003 - 0.005
Carbon Disulfide	1052, 1074, 1079	0.002 - 0.13
Chloroethane	1643	0.025
Chloroform	1031	0.002
1,1-Dichloroethane	1019, 1031, 1073, 1083, 1643	0.002 - 0.076
1,2-Dichloroethane	1031, 1643	0.002 - 0.009
1,1-Dichloroethene	1031, 1073, 1643	0.002 - 0.005
trans-1,2-Dichloroethene	1031	0.018
1,2-Dichloroethylene	1019, 1643	0.01 - 0.025
Methylene Chloride	1019, 1024, 1025, 1027, 1028, 1030, 1031, 1038, 1052, 1073, 1074, 1075, 1076, 1078, 1079, 1080, 1081, 1082, 1083, 1643	0.002 - 0.018
Tetrachloroethene	1031	0.3
Toluene	1027, 1031, 1038, 1081, 1083, 1643	0.001 - 0.002
1,1,1-Trichloroethane	1025, 1073	0.002 - 0.005
Trichloroethene	1025, 1031, 1078, 1083	0.001 - 0.53
Vinyl Chloride	1019, 1031, 1643	0.002 - 0.016
Xylene (Total)	1031	0.002
bis(2-Ethylhexyl)phthalate	1079, 1080	0.003 - 0.004
Butyl benzyl phthalate	1025, 1073, 1078	0.001 - 0.003
Diethyl phthalate	1025, 1079, 1083	0.002 - 0.004
Di-n-butyl phthalate	1021, 1025, 1073, 1074, 1075, 1076, 1078	0.004 - 0.012
4,6-Dinitro-2-methylphenol	1031	0.006
4-Methyl-2-pentanone	1031	0.006
2-Nitrophenol	1031	0.012
4-Nitrophenol	1031	0.011
	Waste Storage Area (cont.)	
N-Nitrosodiethylamine	1031	0.004

See footnotes at end of table

TABLE 4-56
(continued)

Compound	Well Location	Concentrations (mg/ℓ)[b]
N-Nitrosodiphenylamine	1025, 1031, 1052, 1074, 1079, 1080	0.002 - 0.003
Naphthalene	1031	0.002
Pentachlorophenol	1031	0.003
Phenol	1052	0.002
Phenols	1008, 1010, 1011, 1019, 1022, 1024, 1025, 1027, 1029, 1031, 1032, 1033, 1034, 1035, 1038, 1039, 1041, 1042, 1052, 1073, 1074, 1075, 1076, 1077, 1078, 1079, 1080, 1081, 1082, 1083, 1084, 1149	0.005 - 0.24
2,3,4,6-Tetrachlorophenol	1031	0.004
	Production Area	
Acetone	1085, 1086, 1088, 1149, 1172, 1182, 1183, 1186, 1193, 1199, 1206, 1208, 1209, 1212, 1213, 1246, 1250, 1287, 1324, 1363, 1412, 1423, 1441, 1442, 1447, 1448, 1509, 1517	0.002 - 0.059
Benzene	1149, 1172	0.001 - 0.014
2-Butanone	1149, 1172, 1182, 1183, 1186, 1193, 1199, 1208, 1209, 1212, 1213, 1246, 1250, 1287, 1324, 1412, 1423, 1441, 1443, 1447, 1448	0.001 - 0.067
Carbon Tetrachloride	1149	0.005
Carbon Disulfide	1182, 1183	0.002 - 0.003
Chloroform	1149, 1784	0.001 - 0.026
1,1-Dichloroethane	1149, 1172, 1182, 1186, 1199, 1203, 1206, 1208, 1212, 1213, 1246, 1283, 1287, 1324, 1411, 1412, 1423	0.001 - 0.68
1,2-Dichloroethane	1149, 1283, 1412, 1423	0.001 - 0.086
1,1-Dichloroethene	1149, 1199, 1206, 1212, 1283, 1287, 1324, 1411, 1412, 1423	0.001 - 0.46
1,2-Dichloroethylene	1149, 1172, 1203, 1206, 1246, 1250, 1283, 1287, 1324, 1411, 1423	0.001 - 0.59
Ethylbenzene	1172	0.038

See footnotes at end of table

TABLE 4-56
(continued)

Compound	Well Location	Concentrations (mg/ℓ)[b]
	Production Area (cont.)	
Methylene Chloride	1088, 1149, 1182, 1183, 1186, 1193, 1199, 1203, 1206, 1208, 1209, 1212, 1213, 1246, 1283, 1287, 1324, 1363, 1411, 1412, 1423	0.001 - 0.028
Tetrachloroethene	1149, 1206, 1209, 1246, 1250, 1287, 1324, 1363, 1411	0.001 - 0.35
Toluene	1083, 1172, 1324, 1411	0.001 - 0.006
1,1,1-Trichloroethane	1149, 1186, 1199, 1206, 1208, 1209, 1212, 1246, 1250, 1283, 1287, 1324, 1411, 1412, 1423	0.002 - 0.31
1,1,2-Trichloroethane	1324	0.002
Trichloroethene	1149, 1186, 1193, 1206, 1246, 1250, 1283, 1287, 1324, 1411, 1423	0.001 - 6.4
Vinyl Acetate	1172	0.001 - 0.002
Vinyl Chloride	1206, 1411, 1423	0.002 - 0.007
Xylene (Total)	1172	0.3 - 0.4
bis(2-Ethylhexyl) Phthalate	1088	0.006
1,2-Dichlorobenzene	1209	0.004
Di-n-butyl Phthalate	1441	0.003
2,6-Dinitrotoluene	1324	0.006
4-Methyl-2-pentanone	1172, 1183, 1186	0.002 - 0.01
Phenol	1246, 1287, 1363	0.001 - 0.001
Phenols	1053, 1054, 1055, 1064	0.008 - 0.08
Tributyl phosphate	1180	0.41 - 0.45
Heptachlor Epoxide	1324	0.000058
	Sewage Treatment Plant	
Carbon Disulfide	1443, 1447, 1448	0.002 - 0.002
1,1-Dichloroethane	1441, 1442	0.001 - 0.001
1,2-Dichloroethylene	1441, 1442	0.01 - 0.045
Methylene Chloride	1442, 1443, 1447, 1448	0.002 - 0.021
Tetrachloroethene	1441, 1442	0.005 - 0.008
1,1,1-Trichloroethane	1441	0.004
Trichloroehtene	1441, 1442	0.006 - 0.006
Phenol	1447	0.001

See footnotes at end of table

TABLE 4-56
(continued)

Compound	Well Location	Concentrations (mg/ℓ)[b]
	Fire Training Area	
Chloroethane	1509	0.11
1,1-Dichloroethane	1508, 1509, 1515	0.001 - 2.5
1,2-Dichloroethane	1509	0.019
1,1-Dichloroethene	1509	0.49
1,2-Dichloroethylene	1509	1.5
Ethylbenzene	1509	0.013
Methylene Chloride	1508, 1509, 1511, 1513, 1514	0.001 - 0.026
Tetrachloroethene	1509	0.28
Toluene	1509	0.26
1,1,1-Trichloroethane	1509	2.9
Trichloroethene	1509	0.098
Xylene (Total)	1509	0.055
Benzoic Acid	1509	0.025
Benzyl Alcohol	1509	0.005
bis(2-Ethylhexyl) Phthalate	1509	0.004
2,4-Dimethylphenol	1509	0.04
4-Methylphenol	1509	0.015
	Other Areas	
1,1-Dichloroethane	1517	0.009
1,2-Dichloroethylene	1517	0.005
1,1,1-Trichloroethane	1016, 1517	0.002 - 0.005
Trichloroethene	1517	0.007
Phenols	1016, 1018, 1040, 1046, 1047, 1058, 1059, 1060, 1065, 1124	0.005 - 0.1

[a]Based on data available in the Fernald Database as of December 1, 1991.
[b](mg/ℓ) = milligrams per liter.

Also listed in Table 4-56 are a variety of volatile and semivolatile organic compounds detected in perched groundwater from wells located in the vicinity of the sewage treatment plant and the vicinity of the fire training area. 1,1-Dichloroethane, 1,2-dichloroethylene, 1,1,1-trichloroethane, and trichloroethene were also found in wells located in the vicinity of the South Field, Wells 1016 and 1517.

4.1.4.4.2 Great Miami Aquifer Groundwater Quality

Three flow systems of the Great Miami Aquifer converge in the vicinity of the FEMP (Figure 4-1). Groundwater in the Dry Fork Section of the New Haven Trough generally flows from west to east and turns to south following the Paddys Run Outlet. Groundwater in the Shandon Tributary of the New Haven Trough generally flows to the southeast, and groundwater in the Ross Section of the New Haven Trough flows southwest and turns to southeast when it converges with groundwater from the Shandon Tributary. A flow divide exists in the southern portion of the FEMP that separates Dry Fork Section groundwater from Shandon Tributary groundwater. The location of the divide fluctuates, depending on flow conditions. Therefore, mixing occurs along the divide. A sensitivity analysis using a range of groundwater flow conditions showed that the location of the flow divide can fluctuate up to 750 feet on either side of the divide.

Groundwater from the Ross Section does not enter the FEMP. The divide separating the Ross Section groundwater and the Shandon Tributary groundwater is influenced by pumping of the collector wells located near the big bend of the Great Miami River.

Due to the hydrogeological configuration in the vicinity of the FEMP, wells are grouped prior to the analysis of water quality based on where they are located with respect to the groundwater flow divides. Since groundwater samples from different background areas revealed distinguishable chemical characteristics, background wells are also grouped according to the flow regime described previously. Thus, the background wells, as well as the downgradient monitoring wells, are divided into Dry Fork, Shandon, Dry Fork-Shandon Divide, and Ross groups. Because the lower portion of the Great Miami Aquifer is recharged only by groundwater from the Dry Fork section, 4000 Series downgradient wells are included in the Dry Fork group. The combination of analytical results from Dry Fork and Shandon background samples were used to construct the UTLs for the Dry Fork-Shandon Divide groundwater chemistry. Background wells designated in these groups are listed as follows:

- Dry Fork background wells - Wells 2036, 2057, and 2123
- Shandon background wells - Wells 2043, 2050, 2056, 2066, and 2105
- Dry Fork-Shandon Divide background well - Wells 2036, 2043, 2050, 2056, 2057, 2066, 2105, and 2123
- Ross background well - Wells 2026, 2121, 2122, 3063, 3099, and 3100.

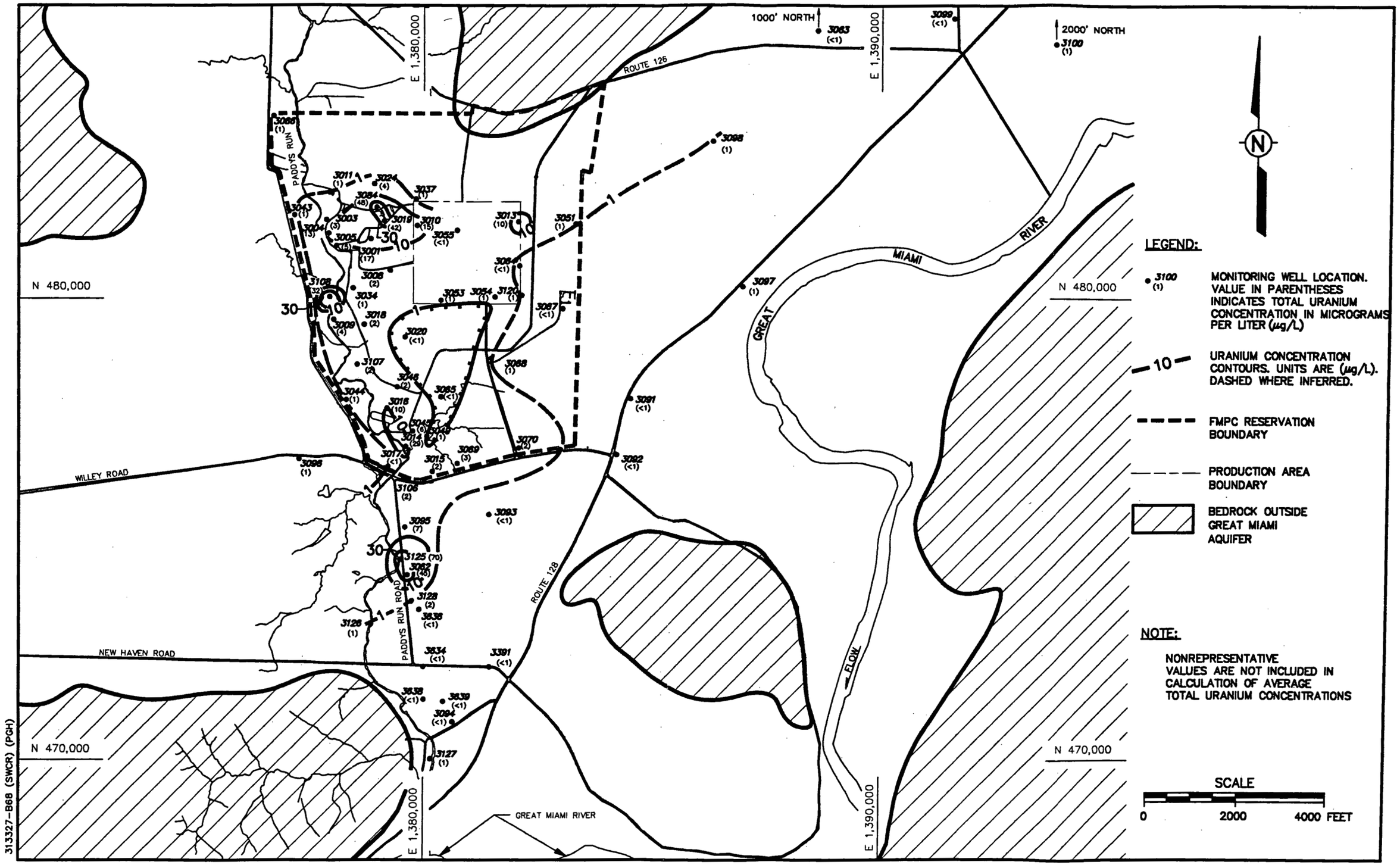


FIGURE 4–3
AVERAGE URANIUM CONCENTRATION IN GROUNDWATER, 3000 SERIES WELLS
SECOND QUARTER 1988 THROUGH SECOND QUARTER 1990

Tables M-5 and M-6 of Appendix M summarized the radiological and nonradiological constituents, respectively, detected in the Great Miami Aquifer background wells located in Dry Fork, Shandon, Dry Fork-Shandon Divide, and Ross background areas.

The only radiological constituents detected in the Dry Fork Background samples were thorium-230 and total uranium. In addition to these two constituents, radium-226 and -228, technetium-99, and thorium-228 were also detected in Shandon background samples. It is noted that technetium-99 is a uranium fission product. Due to its high solubility in water and the nonrecurrent detection in background samples, the detection of technetium-99 in the background sample was most likely related to laboratory contamination. Finally, radiological constituents detected in Ross background samples included radium-226 and -228, thorium-228 and -230, total thorium, and total uranium. Total uranium had the highest frequencies of detections in samples from all background areas.

Calcium dominates the cation concentrations in groundwater samples from all background areas. In Dry Fork and Ross background samples, it was followed by magnesium, sodium, and potassium. In Shandon background samples, sodium concentrations were generally greater than magnesium concentrations. In Dry Fork and Ross background groundwater, sulfate is the dominant anion, followed by chloride and nitrate. However, in Shandon background groundwater, chloride dominates the anion constituents, followed by sulfate and ammonia.

Concentrations of ammonia and nitrate in samples from Dry Fork and Ross background wells are very different from those in samples from Shandon background wells. Average ammonia concentrations in Dry Fork and Ross background samples were 0.098 and 0.077 mg/ℓ, respectively, while the average ammonia concentration in Shandon background samples was 2.81 mg/ℓ. Average nitrate concentrations in Dry Fork and Ross background samples were 5.34 and 5.35 mg/ℓ, respectively, while the average nitrate concentration in Shandon background samples was 0.25 mg/ℓ. These differences indicate that Shandon Tributary of the Great Miami Aquifer is a chemically reduced environment relative to Dry Fork and Ross background areas. Similar indications are also revealed by the differences of iron and manganese between Dry Fork and Ross Background samples and Shandon background samples.

Phenols are the most widespread organic compounds in samples from wells located in all background areas. In addition to phenols, acetone, methylene chloride, n-nitrosodiphenylamine, toluene, bis(2-ethylhexyl) phthalate were detected in Shandon background samples. However, concentrations of these compounds were generally low and might be related to laboratory contaminations.

Radiological Constituents

Upper tolerance limits of radiological constituents detected in background samples were calculated and are listed as follows:

- Dry Fork Background
  - Th-230 - 2.1 pCi/ℓ
  - Total Uranium - 0.001 mg/ℓ

- Shandon Background
  - Ra-226 - 1.75 pCi/ℓ
  - Ra-228 - 4.8 pCi/ℓ
  - Tc-99 - 36 pCi/ℓ
  - Th-228 - 1.8 pCi/ℓ
  - Th-230 - 2.5 pCi/ℓ
  - Total Uranium - 0.002 mg/ℓ

- Dry Fork - Shandon Divide Background
  - Ra-226 - 1.4 pCi/ℓ
  - Ra-228 - 4.8 pCi/ℓ
  - Tc-99 - 36 pCi/ℓ
  - Th-228 - 0.95 pCi/ℓ
  - Th-230 - 1.4 pCi/ℓ
  - Total Uranium - 0.002 mg/ℓ

- Ross Background
  - Ra-226 - 1.1 pCi/ℓ
  - Ra-228 - 4.6 pCi/ℓ
  - Th-228 - 1.4 pCi/ℓ
  - Th-230 - 1.4 pCi/ℓ
  - Total Thorium - 0.005 mg/ℓ
  - Total Uranium - 0.001 mg/ℓ

Radiological constituents detected in 2000, 3000, and 4000 Series well groundwater are summarized in Tables 4-57 and 4-58 and in Tables M-7 to M-9 of Appendix M. Uranium is the most widespread contaminant in the Great Miami Aquifer, as in perched groundwater. Average total uranium concentrations in 2000 and 3000 Series wells are illustrated in Figures 4-2 and 4-3, respectively. Concentrations of uranium in the regional aquifer groundwater in the FEMP area were generally lower than uranium concentrations found in perched groundwater. Wells containing total uranium and uranium isotopes above the UTLs and their average concentration ranges are included in Table 4-58. Uranium-234 and -238 are the dominant uranium species in the regional aquifer at the FEMP.

Statistically elevated uranium concentrations were found in groundwater samples from wells located in the waste storage area, the former production area, the South Field, along Paddys Run, along the SSOD, and other locations. Average concentrations of total uranium in samples from these wells ranged from 0.002 to 0.58 mg/L. The highest concentrations of total uranium were found in a well located northwest of the South Field, Well 2046, and a well located along the SSOD, Well 2387.

Elevated total uranium concentrations were also found in groundwater from wells along Paddys Run between the K-65 silos and its confluence with the SSOD, Wells 2009, 2018, 2044, 2047, 2107, 2108, 3009, 3108, and 4108. Consistently elevated uranium concentrations, ranging from 0.212 to 0.258 mg/ℓ, were found in samples from Well 2397, which is located in the vicinity of the Stormwater Retention Basin.

Total thorium was not detected in any samples from wells located in the Dry Fork and Shandon background areas. Total thorium was detected in samples from wells located in the waste storage area, the former production area, the South Field, along the SSOD, and the downgradient area from the local industries south of the FEMP property (Table 4-58). Additionally, total thorium was also

TABLE 4-57
DETECTIONS OF RADIOLOGICAL CONSTITUENTS IN THE GREAT MIAMI AQUIFER[a] FROM ONGOING RI/FS AND RCRA SAMPLING

Constituent	Concentration Range (pCi/ℓ)[b]	Wells with Repeated Detections	Wells with Detection in the Only Sample[c]
		Waste Storage Area	
Strontium-90	6.8 - 38.5	2021	2649
Technetium-99	123 - 5510	2019, 2021, 2022, 2028	2643, 2649
Thorium-228	1.18 - 4.29	2020	2032
Thorium-230	14.7	NA[d]	2032
		Production Area	
Radium-226	1.1 - 1.3	3055	NA
	1.7 - 1.9	4101	NA
		South Plume Area[e]	
Radium-226	1.0 - 7.7	2014, 2094, 2095, 2559, 2561	NA
	3.3 - 4.8	3094	NA
Radium-228	3.1 - 3.6	2094	NA
	4.5 - 7.1	3094	NA
Strontium-90	7.61 - 38.5	2021, 2128	NA
Technetium-99	46.9	NA	3390
Thorium-228	1.05 - 2.97	2049, 2065, 2094, 2095, 2129, 2391, 2392, 2550, 2551, 2555, 2561	2385, 2554
	1.2 - 2.7	3125, 3128, 3396	NA
	1.2 - 1.7	4125	NA
Thorium-232	1.6 - 2.3	2049	NA
		Other Areas	
Radium-226	1.2 - 8.5	3043, 3066	NA
Radium-228	4.0 - 5.4	2044	NA
Thorium - 228	1.18 - 1.2	2020	NA
Thorium-230	1.04 - 1.8	2018, 2020	NA

[a]Excluding total thorium, uranium isotopes, and total uranium.
[b](pCi/ℓ) = picoCuries per liter.
[c]Only one sample was collected from these wells for the analysis of the specific constituent.
[d]NA = Not applicable.
[e]South Plume Area includes the vicinity of the storm sewer outfall ditch, the Southfield, along Paddys Run south of the FEMP property, and along the local industries on Paddys Run Road.

TABLE 4-58
URANIUM SPECIES AND TOTAL THORIUM IN THE GREAT MIAMI AQUIFER[a] FROM ONGOING RI/FS AND RCRA SAMPLING

Constituent	Wells with Elevated Concentrations[b]	Average Concentration Range (pCi/ℓ)[c]
	Waste Storage Area	
Uranium-234	2004, 2008, 2010, 2011, 2019, 2021, 2022, 2024, 2027, 2028, 2032, 2033, 2034, 2037, 2042, 2052, 2084, 2643, 2648, 2649	0.6 - 13.6
	3001, 3003, 3004, 3005, 3010, 3019, 3024, 3032, 3037, 3054, 3084	0.65 - 13.1
	4011	2.44
Uranium-235/236	2032, 2034, 2648	0.62 - 1.93
	3084	0.85
Uranium-238	2004, 2008, 2010, 2019, 2021, 2022, 2024, 2027, 2028, 2033, 2034, 2037, 2042, 2052, 2084, 2643, 2648, 2649	0.85 - 13.4
	3001, 3003, 3004, 3005, 3008, 3010, 3019, 3024, 3032, 3034, 3037, 3084	0.574- 22.8
	4011	2.23
Total Uraium	2004, 2008, 2010, 2021, 2022, 2024, 2027, 2028, 2032, 2033, 2034, 2037, 2042, 2084, 2643, 2648, 2649	0.003 - 0.04[d]
	3001, 3003, 3004, 3005, 3010, 3019, 3024, 3032, 3037, 3084	0.003 - 0.062[d]
Total Thorium	2010, 2033, 2084	0.002 - 0.004[d]
	3004, 3005, 3011, 3019	0.002 - 0.003[d]
	Production Area	
Uranium-234	2006, 2007, 2013, 2053, 2054, 2055, 2064, 2109, 2118, 2120, 2388, 2389	0.818 - 14.3
	3013	27.1
	4013, 4102, 4103	0.657 - 8.305
Uranium-235/236	2389	1.45
	3013	1.51
Uranium-238	2006, 2007, 2013, 2053, 2054, 2055, 2064, 2109, 2118, 2120, 2388	0.82 - 6.8
	3013, 3054	0.65 - 28.3
	4013, 4102, 4103	0.57 - 8.8

See footnotes at end of table

TABLE 4-58
(continued)

Constituent	Wells with Elevated Concentrations[b]	Average Concentration Range (pCi/ℓ)[c]
	Production Area (cont.)	
Total Uraium	2006, 2007, 2013, 2053, 2054, 2055, 2109, 2118, 2120, 2388, 2389	0.003 - 0.071[d]
	3013	0.067[d]
	4013	0.024[d]
Total Thorium	3054	0.002[d]
	South Plume Area[e]	
Uranium-234	2014, 2015, 2016, 2017, 2045, 2046, 2047, 2048, 2049, 2060, 2061, 2065, 2069, 2094, 2095, 2106, 2125, 2126, 2127, 2128, 2129, 2385, 2386, 2387, 2390, 2391, 2392, 2393, 2394, 2396, 2550, 2551, 2555, 2556, 2558, 2559, 2561	0.635 - 150
	3014, 3015, 3016, 3017, 3046, 3049, 3062, 3069, 3095, 3106, 3125, 3126, 3127, 3128, 3385, 3387, 3390, 3391, 3396	0.7 - 24.3
	4015, 4125	0.6 - 1.6
Uranium-235/236	2014, 2015, 2045, 2046, 2049, 2060, 2061, 2094, 2095, 2106, 2125, 2385, 2387, 2390, 2550, 2551	0.68 - 7.4
	3014, 3015, 3125, 3128, 3390, 3396	0.63 - 1.1
Uranium-238	2014, 2015, 2016, 2017, 2045, 2046, 2048, 2049, 2060, 2061, 2065, 2069, 2094, 2095, 2106, 2125, 2126, 2127, 2128, 2129, 2385, 2386, 2390, 2391, 2394, 2396, 2550, 2551, 2555, 2556, 2558, 2559	0.67 - 157
	3014, 3015, 3016, 3062, 3069, 3095, 3106, 3108, 3125, 3126, 3127, 3128, 3387, 3390, 3391, 3396	0.7 - 25.3
Total Uraium	2014, 2015, 2016, 2017, 2045, 2046, 2049, 2060, 2061, 2065, 2069, 2094, 2095, 2106, 2125, 2127, 2128, 2129, 2385, 2386, 2387, 2390, 2391, 2392, 2393, 2396, 2550, 2551, 2555, 2556, 2558, 2559	0.002 - 0.58[d]
	3014, 3015, 3016, 3062, 3069, 3095, 3125, 3126, 3128, 3385, 3387, 3390, 3391	0.002 - 0.045[d]
	4125	0.004[d]
Total Thorium	2045, 2049, 2127, 2129, 2387, 2391, 2392	0.002 - 0.008[d]
	3014, 3069, 3125, 3385	0.002 - 0.005[d]
	Other Areas	

See footnotes at end of table

TABLE 4-58
(continued)

Constituent	Wells with Elevated Concentrations[b]	Average Concentration Range (pCi/ℓ)[c]
Uranium-234	2009, 2018, 2022, 2044, 2051, 2067, 2092, 2097, 2098, 2107, 2108, 2383, 2397	0.65 - 85.5
	3009, 3018, 3068, 3070, 3107, 3108	0.62 - 10.8
	4097, 4108	0.775 - 14.1
Uranium-235/236	2397	7.1
	4108	0.78
Uranium-238	2009, 2018, 2020, 2044, 2047, 2051, 2067, 2092, 2097, 2107, 2108, 2397	0.67 - 85.2
	3009, 3018, 3107, 3068	0.6 - 1.5
	4096, 4108	0.76 - 12.3
Total Uraium	2009, 2018, 2044, 2047, 2092, 2098, 2107, 2108, 2383, 2397	0.002 - 0.242[d]
	3009, 3108	0.003 - 0.032[d]
	4097, 4108	0.002 - 0.018[d]
Total Thorium	2092, 2018, 2020, 2383	0.002 - 0.005[d]
	3009	0.002[d]

[a]Based on data available in the Fernald Database as of December 1, 1991.
[b]Wells listed contain concentrations of the constituent that are above the UTL.
[c](pCi/ℓ) = picoCuries per liter.
[d]The unit is in mg/ℓ.
[e]South Plume Area includes the vicinity of the storm sewer outfall ditch, the Southfield, along Paddys Run south of the FEMP property, and along the local industries along Paddys Run Road.

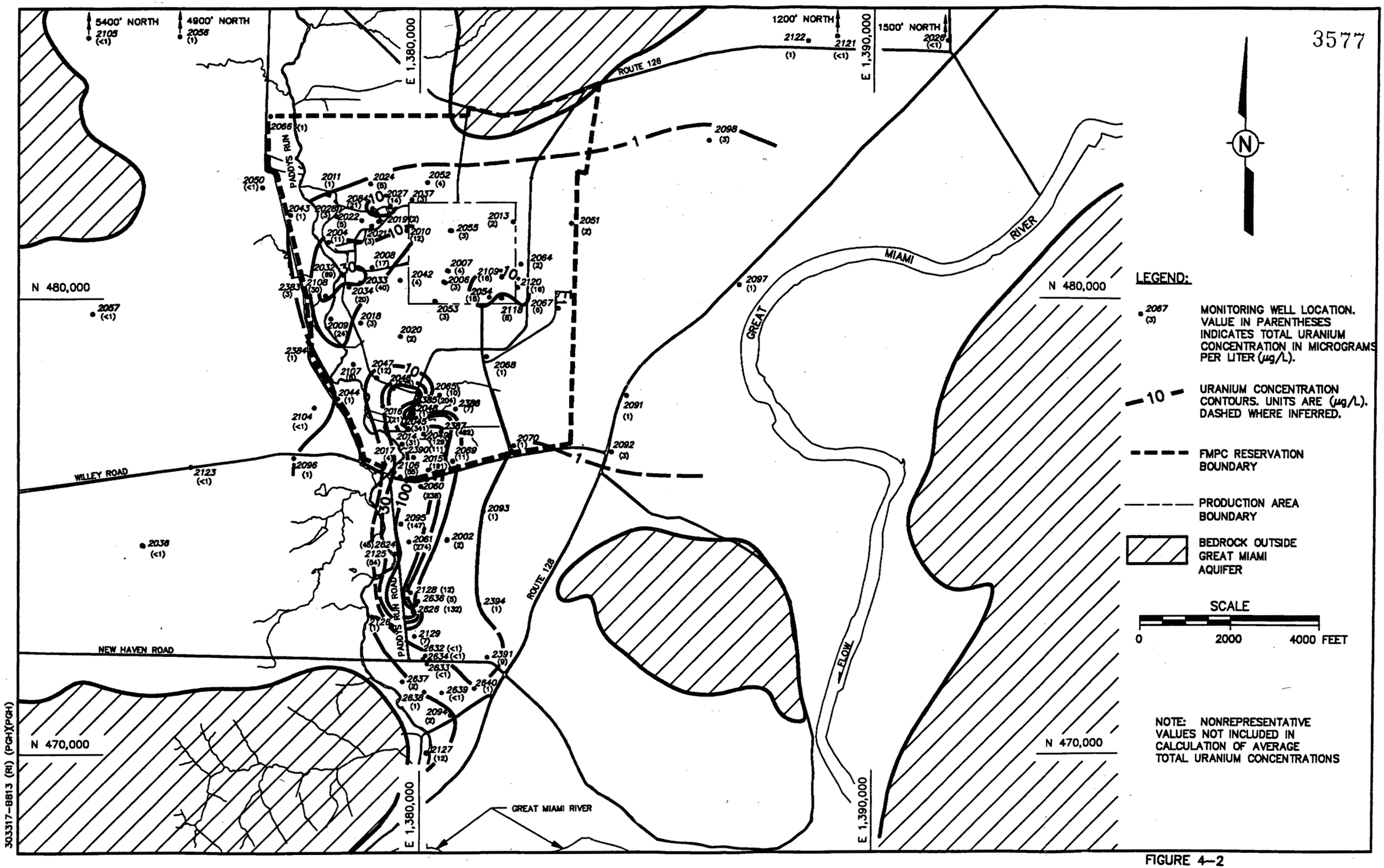


FIGURE 4-2
AVERAGE URANIUM CONCENTRATION
IN GROUNDWATER, 2000 SERIES WELLS
SECOND QUARTER 1988 THROUGH
SECOND QUARTER 1990

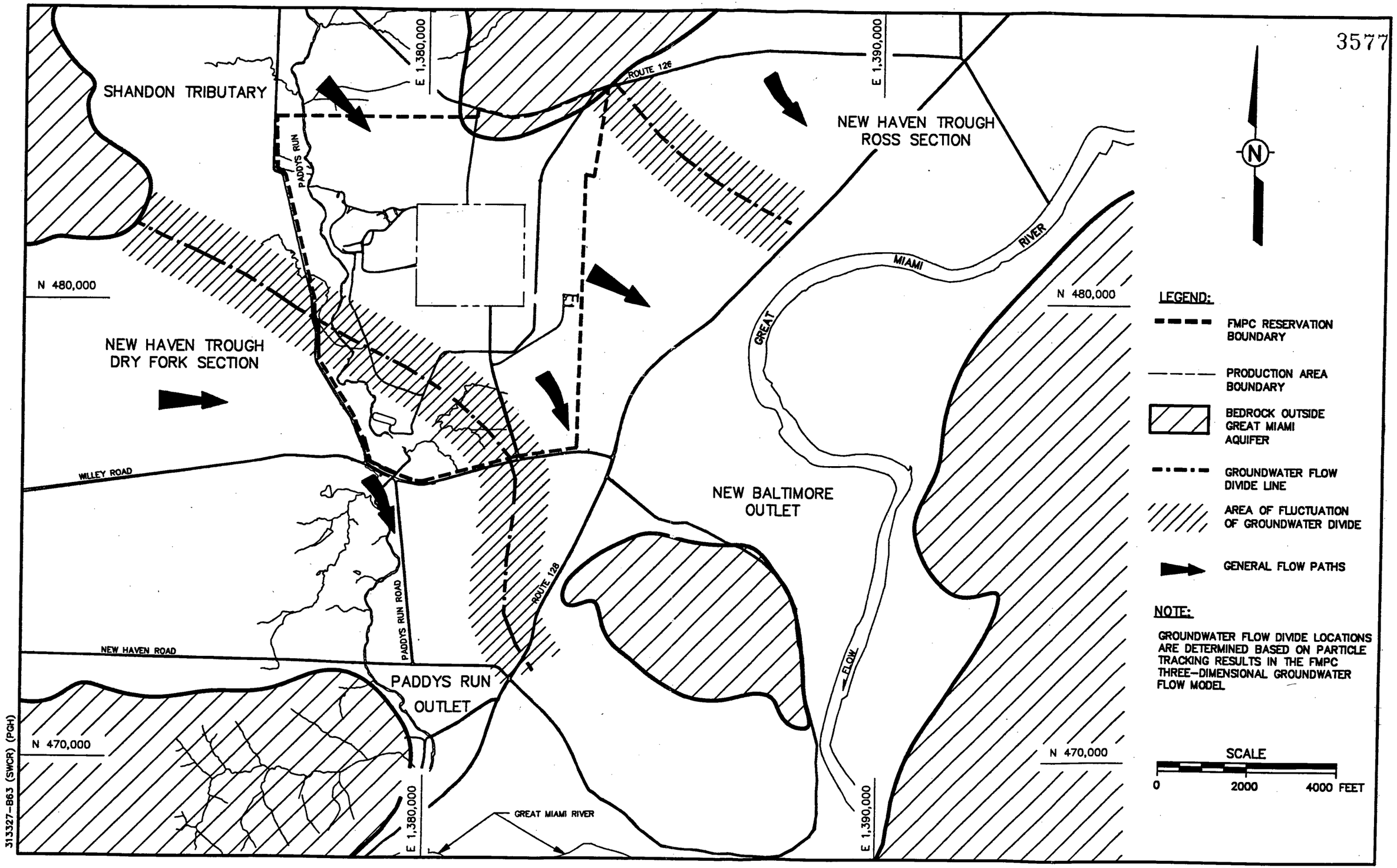


FIGURE 4-1
GROUNDWATER FLOW DIVIDES

detected in wells located outside or upgradient of the FEMP property. Repeated detections of total thorium were only found in samples from Wells 2045, 2020, 2127, 3069, and 3125. Well 2045 is located in the vicinity of the South Field, and Well 3069 is situated along the southern boundary of the FEMP property. Wells 2127 and 3125 are both located along the Paddys Run south of the FEMP property. Well 2020 is located southwest of the former production area. Total thorium concentrations detected in these five wells ranged from 0.002 to 0.010 mg/ℓ.

The majority of detections of radium isotopes, technetium-99, and thorium isotopes in samples from 2000, 3000, and 4000 Series wells were low level and were not recurrent. Wells contain repeated detections of these constituents are listed in Table 4-57. Additionally, technetium-99, thorium-228, and/or thorium-230 were also detected in the only sample collected from Wells 2032, 2385, 2554, 2643, 2649, and 3390.

Samples from wells located in the vicinity of the South Field along the SSOD and Paddys Run downstream from its confluence with the SSOD had repeated detections of radium-226 and -228 and thorium-228 and -232. Among these constituents, radium-226 and thorium-228 were repeatedly detected in samples from Well 2561, which is located approximately 1.5 miles south of the southern boundary of the FEMP. In addition to these locations, radium-226 was repeatedly detected in samples from Wells 3055 and 4101, located in the former production area, and Wells 3043 and 3066, located along the northwestern boundary of the FEMP property. Concentrations of radium-226 in these samples ranged from 1.1 to 8.5 pCi/ℓ. Repeated detections of radium-228 also occurred in samples from Well 2044 located along the southwestern boundary of the FEMP property. Thorium-228 and -230 were repeatedly detected in the only sample collected from Wells 2022 and 2032, and thorium-228 was also repeatedly detected in samples from Well 2018. Well 2032 is located in the vicinity of the K-65 silos, and Wells 2018 and 2020 are located southwest of the former production area.

Samples from wells located in the waste pit area contained consistent detections of technetium-99 with concentrations ranging from 123 to 5510 pCi/ℓ. Technetium-99 was also detected in the only sample collected from Well 3390 located immediately downgradient from the confluence of the Paddys Run and the SSOD.

Cesium-137, plutonium isotopes, ruthenium-106, and uranium-235 were not detected in any RI/FS and RCRA samples. Neptunium-237 was detected in only one sample collected from Well 2004 at 1.0 pCi/ℓ. Detections of strontium-90 in the regional aquifer groundwater were sporadic and inconsistent. Repeated detections of strontium-90 occurred only in samples from Wells 2021 and 2128 with concentrations ranging from 7.61 to 38.5 pCi/ℓ (Table 4-57). The only sample collected from Well 2649 was also found containing strontium-90 concentration of 6.8 pCi/ℓ. Well 2128 is located along Paddys Run Road south of the FEMP property, and Wells 2021 and 2649 are situated in the waste pit

area. As addressed previously, repeated detections of strontium-90 also occurred in perched groundwater collected from the waste pit area.

Metals

Metals detected in 2000, 3000, and 4000 Series well groundwater are summarized in Table 4-59 and Tables M-10 to M-12 of Appendix M. The UTLs calculated from background samples are listed in Table 4-60. Above background concentrations of a variety of metals were found in samples from 2000, 3000, and 4000 Series wells in the waste storage area, the former production area, the South Plume, and other areas (Table 4-59).

General Chemical Parameters

General chemical parameters analyzed in 2000, 3000, and 4000 Series well groundwater are summarized and included in Tables M-10 to M-12 of Appendix M. The UTLs of these parameters calculated from background samples are included in Table 4-61. Wells with groundwater samples containing above background concentrations of these chemicals are listed in Table 4-62. Although analyses of TKN, TOC, TOX, and TON are related to organic compounds, discussions of these parameters are included in this section to characterize general organic chemistry in groundwater samples. As with radiological constituents and metals, above background concentrations of general chemical parameters are present in groundwater samples from a variety of areas on and adjacent to the FEMP.

Nitrate, phosphorus, and sulfate were commonly detected above background in the waste storage area, while sulfate, phosphorus, and sulfide were common in the former production area (Table 4-62). Phosphorus, sulfate, TOC, TOX, and TON were commonly present above background in South Plume samples. In other areas of the FEMP, phosphorus, sulfate, and sulfide were the most common general chemical parameters detected above background.

Organic Compounds

Organic compounds detected in groundwater samples collected from 2000, 3000, and 4000 Series wells are summarized and included in Tables M-10 to M-12 of Appendix M. Fourteen volatile organic compounds, 11 semivolatile organic compounds, and three pesticides were found in samples from the Great Miami Aquifer. PCBs were not detected in any of these samples. Wells where groundwater samples contained organic compounds are listed in Table 4-63. The shallower portion of the regional aquifer, monitored by 2000 Series Wells, revealed more variety and greater area of organic compounds detections than the lower portion of the aquifer that is monitored by 3000 and 4000 Series wells. Organic contaminants were mainly found in areas that are associated with the previous production or the waste storage activities. These areas include the former production area, the waste storage area, the South Field, and the sewage treatment plant. Detections of organic compounds were also reported in groundwater samples from an area inside and south of the local industries located along Paddys Run Road, south of the FEMP property, and along Paddys Run in the

TABLE 4-59
ELEVATED METAL CONCENTRATIONS[a]
IN THE GREAT MIAMI AQUIFER GROUNDWATER
FROM ONGOING RI/FS AND RCRA SAMPLING

Metal	Wells with Elevated Concentrations[b]	Average Concentration Range (mg/ℓ)[c]
	Waste Storage Area	
Aluminum	4001, 4008, 4010	0.096 - 0.114
Antimony[d]	2011, 2052	0.001 - 0.001
Barium	4001, 4010	0.078 - 0.43
Beryllium	4001, 4008, 4010	0.001 - 0.002
Cadmium	3034	0.01
	4001, 4010	0.004 - 0.004
Calcium	2010, 2019, 2021, 2022, 2024, 2027, 2028, 2084	148 - 291
	3010, 3019, 3037, 3084	259 - 282
	4001	106
Chromium	2084	0.041
Cobalt[d]	2010, 2027, 2084	0.007 - 0.009
Iron	2024, 2027	5.0 - 5.9
	3037	12.5
	4001, 4008, 4010	2.4 - 5.1
Magnesium	2022, 2027, 2028, 2034, 2084	51.6 - 77.6
	3037, 3084	63.6 - 78.9
	4010	31.4
Manganese	2010, 2024, 2027, 2037, 2084	0.28 - 0.86
	3001, 3003, 3004, 3005, 3008, 3010, 3019, 3024, 3037, 3084	0.30 - 4.02
Mercury	3004	0.00241
	4001, 4010	0.00014 - 0.00025
Molybdenum	4001, 4008	0.024 - 0.03
Nickel	2011	0.035
	3024	0.141
	4001, 4008, 4010	0.013 - 1.93
Osmium[d]	3084	0.094
Potassium	2021, 2022, 2084	5.5 - 14.3
	3010, 3019, 3037, 3084	7.1 - 16.0
	4001, 4008	3.2 - 4.8

See footnotes at end of table

TABLE 4-59
(continued)

Metal	Wells with Elevated Concentrations[b]	Average Concentration Range (mg/ℓ)[c]
	Waste Storage Area (cont.)	
Silicon[d]	2028, 2032, 2033	2.6 - 4.8
	3032	2.98
	4010	6.43
Silver	2028	0.021
Sodium	4001, 4008, 4010, 4023	8.6 - 30
Thallium[d]	2084	0.001
	3019	0.002
Vanadium	2084	0.051
	3037, 3084	0.036 - 0.041
	4001, 4008, 4010	0.015 - 0.02
Zinc	2004, 2008, 2010, 2019, 2021, 2022, 2027, 2034, 2037, 2042, 2052, 2084	0.013 - 0.111
	3037	0.153
	4001, 4008, 4010	0.017 - 0.028
	Production Area	
Aluminum	4013, 4064, 4101, 4103	0.064 - 0.196
Antimony[d]	2109	0.003
Barium	4013, 4064, 4101, 4102, 4103	0.052 - 0.241
Beryllium	4013, 4101	0.001 - 0.002
Cadmium	2055	0.025
	4013, 4064, 4101, 4103	0.002 - 0.007
Calcium	2051, 2052, 2053, 2054, 2064, 2109, 2118	141 - 304
	3013, 3051, 3055	137 - 179
	4013, 4064, 4101	123 - 227
Chromium	2053, 2054, 2109, 2118	0.042 - 0.073
	4013, 4064	0.039 - 0.046
Cobalt[d]	4101	0.004
Iron	3013, 3055	6.28 - 6.81
	4013, 4064, 4101, 4102, 4103	2.7 - 7.3
Magnesium	2109	55.9
	4013, 4064, 4101	31.1 - 80.2

See footnotes at end of table

TABLE 4-59
(continued)

Metal	Wells with Elevated Concentrations[b]	Average Concentration Range (mg/ℓ)[c]
	Production Area (cont.)	
Manganese	2051, 2053, 2054, 2064, 2109, 2118, 2120	0.274 - 355
	3013	0.37
	4102	9.44
Mercury	4013, 4064, 4103	0.00013 - 0.00065
Molybdenum	3013, 3064	0.03 - 0.058
	4013, 4101, 4103	0.014 - 0.04
Nickel	2054, 2109	0.036 - 0.038
	4013, 4064, 4101	0.014 - 0.029
Potassium	2064	7.94
	3053, 3054, 3055	17.6 - 55.8
	4013, 4101, 4102	2.1 - 4.6
Silicon[d]	2006, 2007, 2053, 2055, 2109, 2120, 2388, 2389	3.2 - 5.9
	3120	5.0
	4013, 4064, 4103	6.25 - 6.42
Silver	2120	0.016
Sodium	4013, 4064, 4101, 4102, 4103	8.02 - 64.4
Vanadium	2109	0.037
	4013, 4064, 4101	0.014 - 0.036
Zinc	2006, 2007, 2013, 2053, 2054, 2109, 2118	0.015 - 0.27
	4013, 4101	0.009 - 0.074
	South Plume Area[e]	
Aluminum	2014, 2015, 2016, 2017, 2045, 2049, 2060, 2061, 2069, 2094, 2095, 2106, 2125, 2126, 2127, 2128, 2129, 2392, 2393, 2396, 2550, 2551, 2555, 2556, 2558, 2559, 2561	0.038 - 0.387
	3014, 3015, 3016, 3017, 3062, 3069, 3094, 3095, 3106, 3125, 3126, 3127, 3128, 3391, 3396	0.068 - 25.9
	4125	0.059
Antimony[d]	2015	0.008
Barium	2015, 2094, 2127, 2392, 2396, 2555, 2559, 2561	0.056 - 1.06
	3016, 3017, 3062, 3069, 3094, 3125, 3127, 3128, 3391, 3396	0.052 - 5.22
	4014, 4015, 4125	0.07 - 0.113
Beryllium	2094, 2129	0.001 - 0.001
	3126	0.002

See footnotes at end of table

TABLE 4-59
(continued)

Metal	Wells with Elevated Concentrations[b]	Average Concentration Range (mg/ℓ)[c]
	South Plume Areas (cont.)	
Cadmium	2014, 2015, 2016, 2017, 2045, 2048, 2049, 2060, 2061, 2065, 2069, 2094, 2095, 2106, 2125, 2126, 2127, 2128, 2129, 2385, 2390, 2393, 2396, 2550, 2551, 2555, 2556, 2558, 2561	0.002 - 0.007
	3014, 3015, 3016, 3017, 3049, 3062, 3069, 3094, 3095, 3106, 3125, 3126, 3127, 3128, 3391, 3396	0.002 - 0.643
	4014, 4015, 4016, 4125	0.002 - 0.005
Calcium	2017, 2045, 2049, 2065, 2126, 2385, 2392, 2393, 2555, 2558, 2559	106 - 167
	3126, 3127, 3391, 3396	108 - 19014
	4015, 4016	105 - 106
Chromium	2016, 2017, 2385, 2555	0.031 - 0.04
	3046, 3069, 3093, 3126, 3127, 3396	0.031 - 4.78
Copper	3127	1.0
Iron	2094, 2559	9.9 - 16.3
	3017, 3062, 3094, 3095, 3106, 3125, 3126, 3127, 3128, 3391, 3396	0.88 - 20.6
	4014, 4015, 4016, 4125	1.3 - 2.6
Lead	2127	0.253
	3127	0.725
Magnesium	2017, 2065, 2094, 2129, 2385, 2392, 2393, 2555, 2559	29.7 - 49.6
	3094, 3095, 3126, 3127, 3396	29.7 - 4881
Manganese	3127	15.3
Mercury	2014, 2016, 2017, 2045, 2048, 2049, 2060, 2069, 2094, 2095, 2125	0.00013 - 0.025
	3014, 3017, 3049, 3062, 3069, 3094, 3095, 3106, 3126, 3127	0.00017 - 0.0213
	4014, 4015	0.00053 - 0.00475
Molybdenum	2014, 2060, 2061, 2069, 2094, 2129, 2393	0.012 - 0.048
	3049, 3094, 3106, 3391	0.011 - 0.02
	4015	0.016
Nickel	2014, 2017, 2049, 2093, 2094, 2095, 2126, 2127, 2129, 2385, 2393, 2550, 2551, 2555, 2556	0.01 - 0.67
	3017, 3046, 3069, 3093, 3094, 3095, 3106, 3125, 3126, 3127, 3391, 3396	0.011 - 2.01
	4015	0.014

See footnotes at end of table

TABLE 4-59
(continued)

Metal	Wells with Elevated Concentrations[b]	Average Concentration Range (mg/ℓ)[c]
	South Plume Areas (cont.)	
Potassium	2014, 2015, 2016, 2045, 2049, 2060, 2061, 2069, 2093, 2094, 2095, 2106, 2125, 2126, 2127, 2128, 2129, 2392, 2393, 2396, 2550, 2551, 2555, 2556, 2558, 2559, 2561	2.1 - 600
	3014, 3015, 3016, 3017, 3049, 3062, 3069, 3094, 3095, 3106, 3125, 3126, 3127, 3128, 3391	2.34 - 537
	4014	2.37
Selenium	2014, 2045, 2049, 2061, 2106, 2129	0.001 - 0.041
	3014, 3015, 3016, 3069, 3127	0.021 - 0.203
	4014	0.002
Silicon[d]	2014, 2016, 2017, 2045, 2046, 2048, 2049, 2061, 2065, 2069, 2093, 2094, 2095, 2106, 2125, 2126, 2127, 2128, 2129, 2385, 2386, 2387, 2390, 2391, 2392, 2393, 2394, 2396, 2397, 2550, 2551, 2555, 2556, 2558, 2559, 2561	2.1 - 17.4
	3014, 3015, 3016, 3017, 3046, 3049, 3062, 3065, 3069, 3093, 3094, 3095, 3106, 3125, 3126, 3127, 3128, 3385, 3387, 3390, 3391, 3396	2.106 - 1540
	4125	6.12
Silver	3127	3.89
Sodium	2014, 2016, 2017, 2045, 2049, 2060, 2061, 2069, 2094, 2095, 2106, 2125, 2126, 2127, 2128, 2129, 2390, 2392, 2393, 2396, 2550, 2551, 2555, 2556, 2558, 2559, 2561	6.5 - 87.8
	3014, 3015, 3016, 3017, 3049, 3062, 3069, 3094, 3095, 3106, 3125, 3126, 3127, 3128, 3391, 3396	9.23 - 1268
	4014, 4015, 4016, 4125	5.12 - 13.3
Thallium[d]	3126	0.002
Vanadium	2014, 2015, 2016, 2017, 2045, 2049, 2061, 2069, 2094, 2095, 2106, 2125, 2126, 2127, 2128, 2129, 2393, 2555, 2556, 2558, 2561	0.008 - 0.02
	3014, 3015, 3016, 3017, 3062, 3069, 3094, 3095, 3106, 3125, 3126, 3127, 3128, 3391, 3396	0.01 - 2.6
	4125	0.01
Zinc	2014, 2015, 2016, 2060, 2094, 2095, 2106, 2129, 2393, 2558	0.017 - 2.3
	3126	0.03

See footnotes at end of table

TABLE 4-59
(continued)

Metal	Wells with Elevated Concentrations[b]	Average Concentration Range (mg/ℓ)[c]
	Other Areas	
Aluminum	2044, 2096, 2098	0.066 - 0.098
	3044, 3096	0.062 - 0.066
	4097, 4108	0.035 - 0.073
Barium	2044, 2096, 2104	0.058 - 0.076
	3044	0.055
	4023, 4067, 4091, 4097	0.052 - 0.092
Cadmium	2018, 2044, 2104, 2384, 2397	0.002 - 0.008
	3044, 3096	0.003 - 0.005
	4067, 4091, 4096, 4097, 4108	0.002 - 0.006
Calcium	2096, 2104, 2383, 2384, 2397	119 - 159
	3066	158
Chromium	2384	0.043
Copper	2091	0.086
Iron	2096, 2098, 2104	0.166 - 2.85
	3009, 3044, 3066	0.77 - 14.7
	4067, 4091, 4097, 4108	0.68 - 3.6
Magnesium	2096, 2104, 2384	30.3 - 44.4
	3108	128
Manganese	3068, 3091, 3092, 3097	0.27 - 0.46
Mercury	2009, 2044, 2070, 2091, 2096, 2104	0.00015 - 0.0018
	3044, 3108	0.00032 - 0.00401
	4067, 4091, 4097	0.00023 - 0.00076
Molybdenum	2104	0.014
	3044	0.016
	4097	0.017
Nickel	2067, 2096, 2104	0.01 - 0.052
	3044, 3068, 3092, 3096	0.012 - 0.059
	4096	0.013
Potassium	2044, 2091, 2104	2.4 - 5.3
	3044, 3096	2.2 - 3.8
	4023, 4097, 4108	2.1 - 2.3
Selenium	2044, 2098	0.003 - 0.022
	3098	0.002
	4067, 4096, 4097	0.001 - 0.002
	Other Areas (cont.)	

See footnotes at end of table

TABLE 4-59
(continued)

Metal	Wells with Elevated Concentrations[b]	Average Concentration Range (mg/ℓ)[c]
Silicon[d]	2018, 2020, 2044, 2047, 2068, 2070, 2091, 2092, 2096, 2097, 2098, 2104, 2107, 2108, 2383, 2384	1.5 - 33.7
	3018, 3020, 3044, 3068, 3070, 3091, 3092, 3096, 3097, 3107, 3108	1.8 - 5.5
	4097, 4108	3.5 - 4.8
Sodium	2044, 2096, 2104	6.3 - 16.4
	3044, 3066	12.4 - 285
	4067, 4091, 4097, 4108	9.4 - 16.8
Vanadium	2044, 2096, 2098	0.011 - 0.018
	3044, 3096	0.01 - 0.011
Zinc	2051	0.065

[a]Based on data available in the Fernald Database as of December 1, 1991.
[b]Wells listed contain concentrations of the constituent that are above the UTL.
[c](mg/ℓ) = milligrams per liter.
[d]This constituent was either not detected or not analyzed for in background samples.
[e]South Plume Areas include the vicinity of the storm sewer outfall ditch, the Southfield, along Paddys Run south of the FEMP property, and along the local industries on Paddys Run Road.

TABLE 4-60
UPPER TOLERANCE LIMITS OF METALS IN THE GREAT MIAMI AQUIFER[a] FROM ONGOING RI/FS AND RCRA SAMPLING

Metal	Dry Fork Group (mg/ℓ)[b]	Shandon Group (mg/ℓ)	Dry Fork-Shandon Divide Group (mg/ℓ)	Ross Group (mg/ℓ)
Aluminum	NA[c]	0.303	0.303	NA
Arsenic	0.28	0.385	0.369	0.376
Barium	0.051	1.05	0.95	0.079
Beryllium	NA	0.004[d]	0.004[d]	NA
Cadmium	ND[e]	0.007	0.005	0.01[d]
Calcium	104	136	129	112
Chromium	0.030	0.039	0.034	0.025
Cobalt	NA	ND	ND	NA
Copper	0.09	0.022[d]	0.03	0.154
Iron	0.602	4.13	3.69	0.126
Lead	0.037	0.051	0.046	0.059
Magnesium	28.0	47.0	41.6	38.0
Manganese	1.03	0.265	0.742	0.035
Mercury	ND	0.00072	0.00047	0.00027
Molybdenum	0.01[d]	0.029	0.021	0.055
Nickel	ND	0.026	0.023	0.022
Potassium	2.04	5.07	6.24	3.09
Selenium	ND	0.13	0.13	ND
Silver	0.061	0.014	0.032	0.033[d]
Sodium	4.77	100	145	28.7
Thallium	NA	ND	ND	NA
Vanadium	NA	0.034	0.034	NA
Zinc	NA	0.109	0.109	NA

[a]Upper tolerance limits for each constituent were calculated from the analytical results of background samples from the ongoing RI/FS and RCRA sampling programs available in the Fernald Database as of December 1, 1991.
[b](mg/ℓ) = milligrams per liter.
[c]NA = This constituent was not analyzed for in background samples from this well group.
[d]This constituent was detected only once at this concentration in samples from this well group.
[e]ND = This constituent was not detected in background samples from this well group.

TABLE 4-61
UPPER TOLERANCE LIMITS OF GENERAL CHEMICAL PARAMETERS[a] IN THE GREAT MIAMI AQUIFER GROUNDWATER FROM ONGOING RI/FS AND RCRA SAMPLING

Parameter	Dry Fork Group (mg/ℓ)[b]	Shandon Group (mg/ℓ)	Dry Fork-Shandon Divide Group (mg/ℓ)	Ross Group (mg/ℓ)
Ammonia	0.37	7.13	6.00	0.18
Chloride	30.1	110	103	105
Cyanide	NA[c]	ND[d]	ND	NA
Fluoride	0.47	1.33	1.27	0.37
Nitrate	19.4	1.53	7.99	21.7
Phosphate	NA	1.0	1.0	NA
Phosphorus	0.16	0.73	0.45	0.13
Sulfate	60	130	153	131
Sulfide	NA	ND	ND	NA
TKN[e]	0.58	6.63	8.08	0.63
TOC[f]	NA	11.9	11.9	NA
TOX[g]	ND	0.096	0.078	ND
TON[h]	0.31	2.12	1.17	0.40

[a]Upper tolerance limits for each constituent were calculated from the analytical results of background samples from the ongoing RI/FS and RCRA sampling programs available in the Fernald Database as of December 1, 1991.
[b](mg/ℓ) = milligrams per liter.
[c]NA = This constituent was not analyzed for in background samples from this well group.
[d]ND = This constituent was not detected in background samples from this well group.
[e]TKN = total Kjeldahl nitrogen.
[f]TOC = total organic carbon.
[g]TOX = total organic halides.
[h]TON = total organic nitrogen.

TABLE 4-62
ELEVATED GENERAL CHEMICAL CONCENTRAITONS[a]
IN THE GREAT MIAMI AQUIFER GROUNDWATER
FROM ONGOING RI/FS AND RCRA SAMPLING

Parameter	Wells with Elevated Concentrations[b]	Average Concentration Range (mg/ℓ)[c]
	Waste Storage Area	
Ammonia	3037	12.2
	4010	2.96
Chloride	2022, 2084	137 - 188
	3037, 3084	184 - 210
	4010	36
Fluoride	4010	0.5
Nitrate	2008, 2019, 2021, 2022, 2028, 2032, 2033, 2034, 2084	1.9 - 52
	3008, 3010, 3019, 3032, 3034, 3084	3.1 - 13.9
Phosphate	2010	3.6
	4008	0.68
Phosphorus	2010, 2024, 2027, 2032, 2033, 2034, 2052	0.89 - 174.4
	3011, 3034	0.94 - 139
	4001, 4008, 4010	0.17 - 0.25
Sulfate	2010, 2024, 2027, 2037, 2052, 2084	144 - 534
	3010, 3019, 3037, 3084	385 - 559
	4001	65.4
Sulfide	2033	8.0
	4010	25.8
TKN[d]	3037	17.7
	4001, 4010	2.8 - 3.3
TOC[e]	4001, 4008, 4010	1.6 - 12.2
TOX[f]	4010	0.03
TON[g]	2021	2.5
	3037	4.2
	4001	2.01
	Production Area	
Ammonia	4013, 4064, 4101, 4102	0.47 - 3.91
Chloride	4013, 4064, 4101, 4102, 4103	30.1 - 295
Cyanide	2054	0.003

See footnotes at end of table

TABLE 4-62
(continued)

Parameter	Wells with Elevated Concentrations[b]	Average Concentration Range (mg/ℓ)[c]
	Production Area (cont.)	
Fluoride	3120	11.6
	4013	0.49
Phosphate	3013	1.2
	4101, 4102, 4103	0.16 - 0.20
Phosphorus	2007, 2053, 2055, 2118, 2388	0.77 - 9.5
	4064, 4103	0.208 - 0.225
Sulfate	2006, 2007, 2053, 2054, 2055, 2064, 2118, 2388, 2389	130 - 666
	3013, 3055	269 - 324
	4013, 4064, 4101, 4103	62.5 - 322
Sulfide	2006, 2007, 2053, 2055, 2109	12.8 - 90.2
	3120	1.8
	4064, 4103	17 - 40
TKN	4013, 4064, 4101, 4102	0.69 - 5.14
TOC	2055	13.6
	4013	2.6
TOX	2006	0.27
	4013, 4101	0.019 - 0.039
TON	2055	2.9
	3055	2.7
	4101	1.12
	South Plume Areas[h]	
Ammonia	2094, 2127, 2559	0.58 - 1.37
	3094	2.3
Chloride	2069, 2094, 2396, 2555, 2559	36 - 133
	3069, 3094	32 - 114
	4015	31.2
Fluoride	2015, 2060, 2094	0.47 - 0.75
Nitrate	2126, 2128, 2555, 2556	21.6 - 100.6
	3126	112.6
Phosphate	2014, 2016, 2017	0.01 - 0.30
	3017	0.01

See footnotes at end of table

TABLE 4-62
(continued)

Parameter	Wells with Elevated Concentrations[b]	Average Concentration Range (mg/ℓ)[c]
	South Plume Areas (cont.)	
Phosphorus	2014, 2045, 2048, 2049, 2094, 2095, 2106, 2125, 2126, 2127, 2128, 2129, 2386, 2390, 2391, 2392, 2393, 2396, 2550, 2551, 2555, 2556, 2558, 2559, 2561	0.185 - 20.3
	3017, 3049, 3069, 3094, 3095, 3106, 3126	0.168 - 92
	4125	0.295
Sulfate	2014, 2015, 2016, 2017, 2065, 2069, 2094, 2106, 2126, 2127, 2129, 2392, 2393, 2396, 2555, 2558	60 - 5431
	3015, 3016, 3017, 3049, 3069, 3094, 3095, 3106, 3125, 3128, 3391, 3396	65 - 275
	4014, 4015, 4016	65 - 104
Sulfide	2014, 2046, 2048, 2126, 2127, 2129, 2386, 2390	0.135 - 12.8
	3046, 3069, 3127	0.5 - 7.1
TKN	2014, 2069, 2094, 2127, 2129	0.63 - 2.1
	3062, 3094, 3128	0.58 - 4.1
TOC	2014, 2015, 2016, 2017, 2045, 2049, 2060, 2069, 2095, 2106, 2125, 2126, 2127, 2128, 2129, 2385, 2386, 2390, 2392, 2393, 2396, 2550, 2551, 2555, 2556, 2558, 2559, 2561	0.98 - 87
	3014, 3015, 3016, 3017, 3049, 3095, 3106, 3125, 3126, 3127, 3128, 3391, 3396	0.75 - 4.5
	4125	3.3
TOX	2014, 2015, 2017, 2045, 2060, 2094, 2095, 2106, 2127, 2128, 2386, 2551, 2556, 2558, 2559	0.006 - 6.9
	3014, 3015, 3017, 3049, 3094, 3095, 3106, 3125, 3126, 3127, 3128, 3385, 3387, 3391, 3396	0.01 - 2.3
	4016	0.013
TON	2014, 2045, 2049, 2095, 2106, 2125, 2127, 2128, 2129, 2390, 2550, 2551	0.32 - 1.16
	3062, 3069	0.35 - 1.7
	Other Areas	
Ammonia	3066	17.0
	4108	0.69
Chloride	2044	36.9
	3066	605
Nitrate	2091, 2092, 2097	2.3 - 6.4
Phosphate	3066	1.1

See footnotes at end of table

TABLE 4-62
(continued)

Parameter	Wells with Elevated Concentrations[b]	Average Concentration Range (mg/ℓ)[c]
	Other Areas (cont.)	
Phosphorus	2044, 2067, 2068, 2070, 2096, 2097, 2098, 2107, 2108	0.24 - 107
	3044, 3066, 3068, 3070, 3092, 3096	0.24 - 110
	4067, 4096	0.23 - 0.37
Sulfate	2044, 2096, 2104, 2051, 2097, 2383, 2397	77 - 303
	3044	99.8
Sulfide	2047, 2097, 2098, 2107, 2108	9.5 - 44.2
	3098, 3107, 3108	22.5 - 28.0
	4097	19.5
TKN	3066	14.6
TOC	2044, 2104	1.0 - 1.0
	3096	1.0
	4108	2.2
TOX	2098	0.014
	3096, 3098	0.013 - 0.018
	4067, 4091, 4096, 4097	0.02 - 0.07
TON	2096, 2108	0.41 - 1.8
	4108	0.64

[a]Based on data available in the Fernald Database as of December 1, 1991.
[b]Wells listed contain concentrations of the constituent that are above the UTL.
[c](mg/ℓ) = milligrams per liter.
[d]TKN = total Kjeldahl nitrogen.
[e]TOC = total organic carbon.
[f]TOX = total organic halides.
[g]TON = total organic nitrogen.
[h]South Plume Areas include the vicinity of the storm sewer outfall ditch, the Southfield, along Paddys Run south of the FEMP property, and along the local industries on Paddys Run Road.

TABLE 4-63
ORGANIC COMPOUNDS DETECTED IN THE GREAT MIAMI AQUIFER GROUNDWATER[a] DURING ONGOING RI/FS AND RCRA SAMPLING

Compound	Well Location	Concentrations (mg/ℓ)[b]
	Waste Storage Area	
Acetone	2010, 2011, 2019, 2021, 2027, 2034, 2037, 2042, 2052, 2084	0.002 - 0.037
	3001, 3008, 3019, 3024, 3037, 3084	0.003 - 0.037
	4001, 4008, 4010	0.001 - 0.035
Benzene	2010, 2037	0.001 - 0.001
	3001	0.004
2-Butanone	2004, 2019	0.001 - 0.002
	3019	0.003
Carbon Disulfide	2011, 2027, 2037	0.001 - 0.011
Ethylbenzene	2034	0.002
	3001	0.002
Methylene Chloride	2004, 2006, 2008, 2010, 2011, 2019, 2021, 2027, 2034, 2037, 2042, 2084	0.001 - 0.022
	3001, 3008, 3019, 3024, 3037, 3084	0.002 - 0.011
	4001, 4008, 4010	0.001 - 0.011
Toluene	2010, 2011, 2019, 2021	0.002 - 0.005
	3001, 3008, 3019, 3037	0.002 - 0.01
	4001, 4008, 4010	0.002 - 0.005
Trichloroethene	3037	0.003
Trichlorofluoromethane	2019	0.066
	3019	0.072
Xylene (Total)	2034	0.003
	3001	0.003
bis(2-Ethylhexyl)phthalate	2008, 2010, 2019, 2021, 2022, 2027, 2037	0.001 - 0.05
	3019, 3037	0.002 - 0.005
	4001	0.005
Butyl benzyl phthalate	2034	0.001 - 0.001
	3037	0.003
Diethyl phthalate	2010, 2021	0.001 - 0.007
	3037	0.002

See footnotes at end of table

TABLE 4-63
(continued)

Compound	Well Location	Concentrations (mg/ℓ)[b]
	Waste Storage Area (cont.)	
Di-n-butyl phthalate	2004, 2008, 2010, 2034, 2037	0.003 - 0.008
	3001, 3084	0.002 - 0.005
2,6-Dinitrotoluene	4001	0.002
Isophorone	2011	0.002
3-Nitroaniline	2011	0.05
4-Nitrophenol	2021	0.003
N-Nitrosodiphenylamine	2011, 2019, 2027, 2037	0.002 - 0.01
	3019, 3037	0.002 - 0.003
Phenol	2008	0.002
	3037	0.017
Phenols	2004, 2008, 2010, 2011, 2019, 2021, 2022, 2024, 2027, 2032, 2033, 2034, 2037, 2042, 2052, 2084	0.006 - 0.17
	3001, 3003, 3004, 3005, 3010, 3011, 3013, 3019, 3024, 3032, 3034, 3037	0.006 - 1.2
	4001, 4008, 4010	0.017 - 0.068
alpha-BHC	2022	0.0001
Aldrin	2022	0.00011
Heptachlor	2022	0.00007
	Production Area	
Acetone	2006, 2007, 2053, 2055	0.005 - 0.018
	3010, 3013, 3055	0.004 - 0.035
	4013, 4101, 4103	0.001 - 0.005
2-Butanone	2006, 2007, 2053	0.002 - 0.004
2-Hexanone	4101	0.003
Methylene Chloride	2007, 2013, 2053, 2055	0.008 - 0.012
	3010, 3013, 3055	0.002 - 0.01
	4013	0.012
4-Methyl-2-pentanone	3001	0.003
	4101	0.003
	Production Area (cont.)	
Toluene	2006, 2055	0.002 - 0.003

See footnotes at end of table

TABLE 4-63
(continued)

Compound	Well Location	Concentrations (mg/ℓ)[b]
	3010, 3055	0.002 - 0.002
Trichloroethene	3010	0.002
bis(2-Ethylhexyl) phthalate	2109	0.014
Di-n-butyl phthalate	2054, 2109	0.004 - 0.01
n-Nitrosodiphenylamine	2109	0.003
Phenol	2007	0.014
Phenols	2006, 2007, 2013, 2053, 2054, 2055, 2118, 2120, 2389	0.012 - 0.227
	3053, 3054, 3055, 3064, 3120	0.007 - 0.165
	4013, 4064, 4101, 4102, 4103	0.007 - 0.028
	South Plume Areas	
Acetone	2014, 2015, 2060, 2094, 2095, 2106, 2129	0.002 - 0.011
	3126	0.007
Benzene	2094	0.16
	3126	0.001
2-Butanone	2015, 2060, 2095, 2106, 2129	0.004 - 0.035
	3126	0.004
Chloroform	2015	0.002
Ethylbenzene	2094	0.001
2-Hexanone	2095	0.001
Methylene chloride	2015, 2060, 2094, 2095, 2106	0.002 - 0.047
	3126	0.002
Toluene	2094	0.004
	3126	0.005
1,1,1-Trichloroethane	2015, 2060, 2095, 2106	0.001 - 0.01
Xylene (Total)	2094	0.007 - 0.19
Trichloroethene	2106	0.002
bis(2-Ethylhexyl)phthalate	2014, 2015, 2016	0.001 - 0.004
	South Plume Areas (cont.)	
Di-n-butyl phthalate	2094	0.003
Diethyl phthalate	2065	0.02
Phenols	2014, 2017, 2045, 2046, 2047, 2048, 2049, 2060, 2061, 2065, 2069, 2094, 2095, 2106, 2125, 2126, 2127, 2128, 2129, 2387, 2391, 2394, 2396, 2550, 2551, 2555, 2559	0.005 - 0.34

See footnotes at end of table

TABLE 4-63
(continued)

Compound	Well Location	Concentrations (mg/ℓ)[b]
	3014, 3015, 3017, 3049, 3062, 3065, 3069, 3094, 3095, 3106, 3125, 3126, 3127, 3128, 3391	0.01 - 11.5
	4014, 4015, 4016, 4125	0.01 - 0.1
	Other Areas	
Acetone	2051	0.003 - 0.028
	3043, 3051, 3066	0.004 - 0.084
Carbon disulfide	3043	0.003
Methylene chloride	2051	0.002 - 0.009
	3043, 3051, 3066	0.001 - 0.009
Toluene	2051	0.002
	3043, 3051, 3066	0.002 - 0.008
Trichloroethene	3043, 3051	0.002 - 0.009
N-Nitrosodiphenylamine	2020	0.021
Di-n-butyl phthalate	3043	0.01
Phenols	2009, 2018, 2020, 2044, 2051, 2064, 2067, 2068, 2070, 2091, 2092, 2093, 2096, 2097, 2104, 2107, 2383, 2384	0.01 - 0.22
	3009, 3018, 3020, 3043, 3044, 3051, 3068, 3070, 3092, 3093, 3096, 3097, 3098, 3107	0.006 - 0.37
	4023, 4091, 4096, 4097, 4108	0.008 - 0.172
bis(2-Ethylhexyl)phthalate	3043	0.015

[a]Based on data available in the Fernald Database as of December 1, 1991.
[b](mg/ℓ) = milligrams per liter.

vicinity. This contamination plume has partially overlapped with the South Plume that originated from inside of the FEMP property. In addition to these traceable organic contaminations, various organic compounds at low concentrations were also sporadically detected in samples from other areas.

Acetone, 2-butanone, methylene chloride, toluene, and phthalates were found in samples from many wells. However, these compounds are recognized as common laboratory contaminants. With the exceptions of the detections of acetone in Wells 2011 and 2019, methylene chloride in Well 2019, toluene in Well 3001, di-n-butyl phthalate in Wells 2109 and 3043, diethyl phthalate in Well 2065, and bis(2-ethylhexyl)phthalate in 3043, their concentrations were either lower than the detection limits and/or were reported in conjunction with detections in the associated method blanks. Wells 2011, 2019, and 3001 are located in the waste pit area, and Well 2109 is located in the former production area. Well 2065 is located south of the stormwater retention basin, and Well 3043 is located along the western boundary of the FEMP property west of the Waste Storage Area.

Phenols are the most widespread organic compounds in the Great Miami Aquifer. This is most likely attributable to their high solubilities in water. Phenols were detected in 37 samples out of the 62 samples from the background wells. The UTLs of phenols calculated from background samples for Dry Fork, Shandon, Dry Fork-Shandon Divide, and Ross background wells are 0.034, 0.061, 0.036, and 0.032 mg/ℓ, respectively. The maximum phenols concentration in downgradient wells, 11.5 mg/L, was reported in a sample from Well 3126. However, this analytical result may not be reliable, since the other phenols analytical results in samples from this wells ranged from below the 0.01 mg/L detection limit to 0.03 mg/ℓ. Excluding Well 3126, the maximum phenols concentration, 1.2 mg/L, was reported in a sample from Well 3001. Excluding Well 3126, phenols concentrations above the UTLs were only found in Wells 2007, 2018, 2037, 2048, 3001, 3044, 4010, 4014, and 4097. Well 2007 is located in the former production area, and Wells 2018, 2037, 3001, and 4010 are located inside of or directly downgradient from the Waste Storage Area. Wells 2048 and 4014 are located in the vicinity of the South Field. Well 3044 is located along the southwestern boundary of the FEMP property, and Well 4097 is located near the big band of the Great Miami River.

Detections of other organic compounds were generally low level and inconsistent. Detections of organic compounds with concentrations above the detection limits were found only in wells located in the waste storage area, the former production area, the South Plume, and downgradient from the local industries south of the FEMP property. Wells where groundwater contained above detection limit concentrations of organic compounds include:

- Well 2007 - Phenol
- Well 2011 - Carbon disulfide, N-nitrosodiphenylamine, 3-Nitroaniline
- Well 2015 - 1,1,1-Trichloroethane
- Well 2022 - Aldrin, alpha-BHC, Heptachlor
- Well 2027 - Carbon disulfide

- Well 2037 - Carbon disulfide
- Well 2060 - 1,1,1-Trichloroethane
- Well 2094 - Benzene, Xylene (total)
- Well 2106 - 1,1,1-Trichloroethane
- Well 3037 - Phenol

The pesticides aldrin, alpha-BHC, and heptachlor were found only in Well 2022 with concentrations ranging from 0.07 to 1.10 µg/ℓ. Well 2022 is located between Pit 3 and Pit 4 in the Waste Storage Area.

4.1.5 Surface Soils

Surface soil sampling has been routinely conducted on-property and off-property in the vicinity of the FEMP. Specific waste units and their corresponding operable units are listed in Table 4-64. With some exceptions, uranium was the only parameter analyzed in off-property samples.

Sampling conducted by IT (1986) indicated that total uranium concentrations in soil decreased with distance from the FEMP. Annual sampling of surface soil conducted by NLO (1985b) and WMCO (1985-1990) consistently reported the highest concentrations of uranium in samples from the vicinity of the former incinerator adjacent to the sewage treatment plant. Weston (1987c) found that depleted uranium was the dominant radionuclide present in soil samples from the waste storage area, with thorium also present in samples from the waste pits and flyash disposal areas. Radionuclide results from DOE (1988) were similar to those of other surface sampling efforts, with uranium the dominant contaminant detected. Chemical analyses found several volatile organic compounds, including acetone, chloroform and methylene chloride (DOE 1988). RI/FS surface soil sampling at the FEMP also detected isotopes of uranium in near surface soils, as well as isotopes of thorium, strontium-90 and technetium-99.

4.1.5.1 "Interim Report - Air, Soil, Water, and Health Risk Assessment in the Vicinity of the FMPC, Fernald, Ohio," (IT, 1986)

IT (1986) conducted a soil deposition assessment to describe the concentration of uranium in surface soils surrounding the FEMP and to assess the NLO (1985) data. Sixty-seven samples were collected in close proximity to the samples collected in 1984 to independently establish confidence in the data. Regression analysis of these paired observations showed that the 1984 data provided as good a description of the uranium concentration as the 1986 data and could be used with confidence to describe the regional distribution of uranium in soil.

Total uranium concentrations ranging from 0.5 to 90.6 pCi/g (Table 4-65). The highest concentrations were found in the northeast quadrant of the sampling area, in the samples taken within one mile of the FEMP. Total uranium concentrations decreased with distance from the FEMP (Figure 4-4 and Figure 4-5).

4.1.5.2 "Feed Materials Production Center Environmental Monitoring Annual Report for 1984," (NLO, 1984)

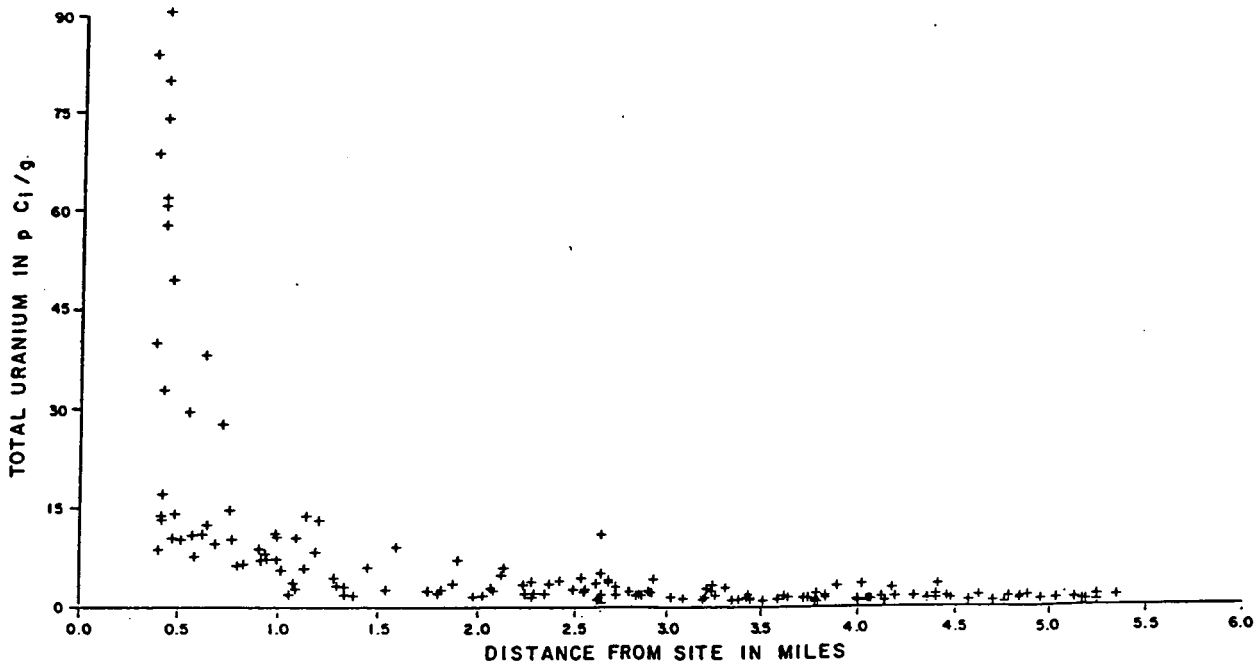
Total uranium concentrations in samples from the 15 routine locations ranged from 1.80 to 68.50 pCi/g (Table 4-66). The highest uranium concentrations were measured in the vicinity of the former incinerator adjacent to the sewage treatment plant. The 105 additional samples collected in 1984 were used to construct a map showing the uranium concentration profile in the top 5 cm of soil (Figure 4-6). Above background uranium concentrations were present in soils immediately east of the FEMP, possibly associated with the former operation of the incinerator. The high concentration detected east

TABLE 4-64
General Sampling Locations Associated with Operable Units 1, 2, 4, and 5[a]

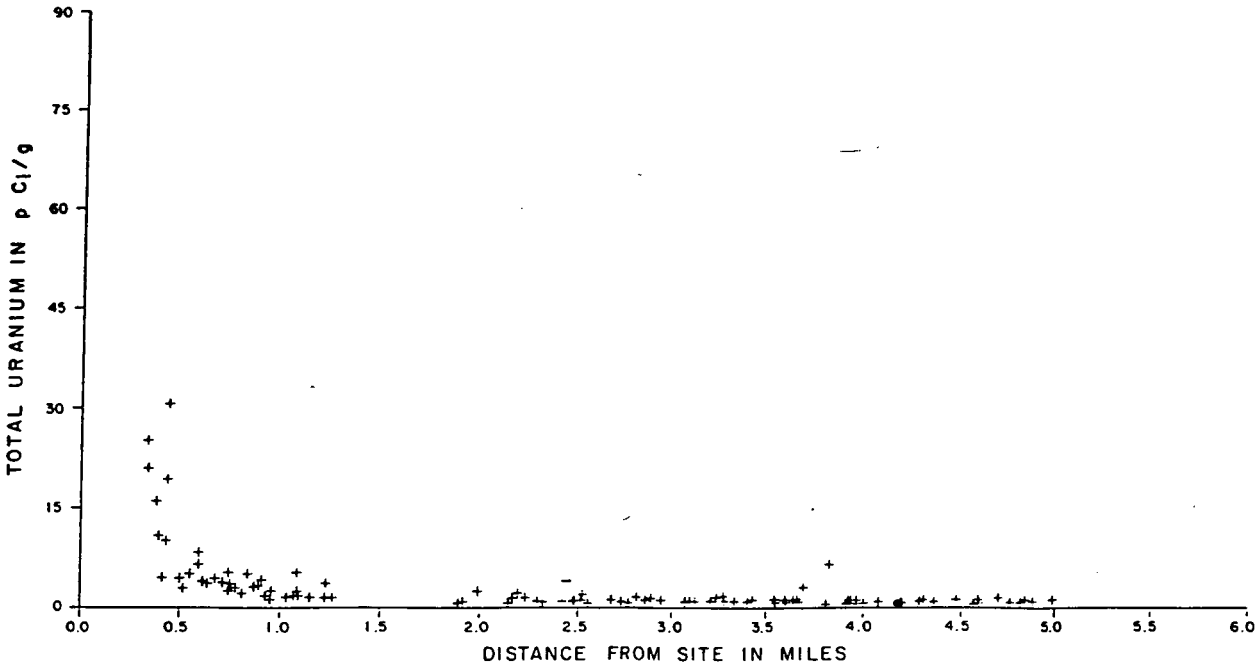
Sampling Location	Associated Operable Unit
Waste Pit 1	Operable Unit 1
Waste Pit 2	Operable Unit 1
Waste Pit 3	Operable Unit 1
Waste Pit 4	Operable Unit 1
Waste Pit 5	Operable Unit 1
Waste Pit 6	Operable Unit 1
Burn Pit	Operable Unit 1
Clearwell	Operable Unit 1
Berm of Waste Pit 1	Operable Unit 1
Berm of Waste Pit 3	Operable Unit 1
Waste Storage Area	Operable Unit 1
Active Flyash Pile	Operable Unit 2
Inactive Flyash Pile	Operable Unit 2
South Field Area	Operable Unit 2
Solid Waste Landfill	Operable Unit 2
North Lime Sludge Pond	Operable Unit 2
South Lime Sludge Pond	Operable Unit 2
K-65 Berms	Operable Unit 4
K-65 Slant Borings	Operable Unit 4
Silo Area	Operable Unit 4
NE Quadrant	Operable Unit 5
NW Quadrant	Operable Unit 5
SE Quadrant	Operable Unit 5
SW Quadrant	Operable Unit 5
Incinerator/Waste Water Treatment Facility	Operable Unit 5

TABLE 4-65
Total U in Surface Soils by Quadrant and Distance from the FEMP (IT, 1986)

	Distance (Miles)				
	0-1	1-2	2-3	3-4	4-5
NE Quadrant					
Range (pCi/g)	3.0-90.6	1.6-13.8	0.7-11.0	0.8-3.2	0.7-3.5
Arithmetic Mean	29.1	5.1	3.0	1.5	1.4
Standard Deviation	26.5	3.6	1.8	0.6	0.7
SE Quadrant					
Range (pCi/g)	1.2-30.6	0.7-5.3	0.7-2.2	0.5-6.5	0.5-1.2
Arithmetic Mean	7.3	2.1	1.2	1.2	1.0
Standard Deviation	7.4	1.3	0.4	1.5	0.2
SW Quadrant					
Range (pCi/g)	2.9-20.7	0.8-7.3	0.7-5.3	0.6-2.6	0.8-1.6
Arithmetic Mean	6.7	2.0	2.1	1.2	1.2
Standard Deviation	4.8	1.7	1.4	0.5	0.3
NW Quadrant					
Range (pCi/g)	1.5-35.6	0.6-4.6	0.9-13.2	0.5-2.4	0.6-1.5
Arithmetic Mean	8.9	2.8	2.2	1.0	1.0
Standard Deviation	7.2	1.0	2.8	0.5	0.2



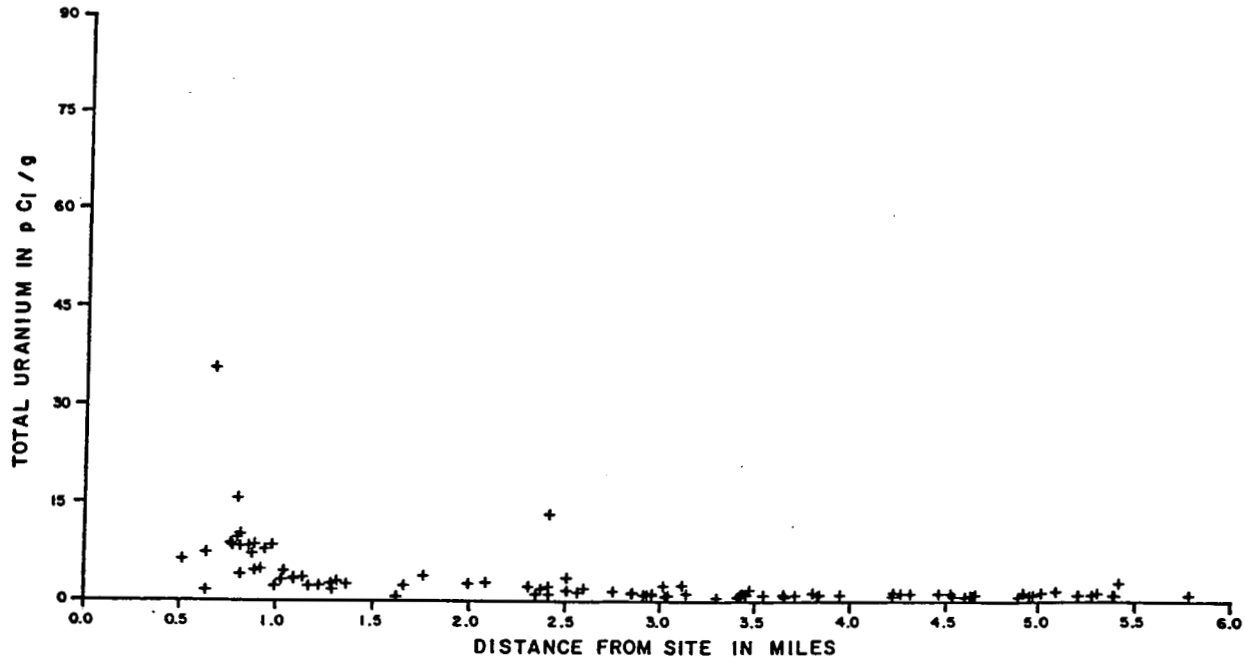
NE QUADRANT



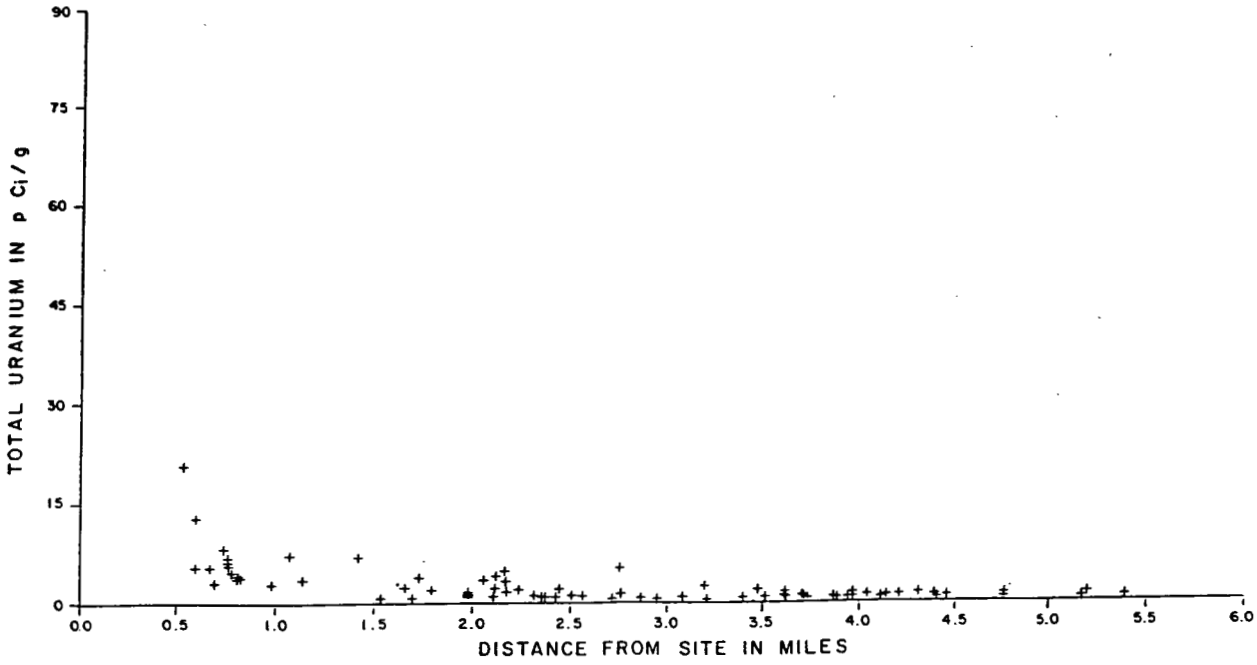
SE QUADRANT

313327.A_TITLES2_SCR_CIN

FIGURE 4-4 GRAPHS OF TOTAL URANIUM IN SOIL VS DISTANCE FROM THE FEMP BY QUADRANT – IT 1986



NW QUADRANT



SW QUADRANT

313327.A_TITLES2_SCR_CIN

FIGURE 4-5 GRAPHS OF TOTAL URANIUM IN SOIL VS DISTANCE FROM THE FEMP BY QUADRANT – IT 1986

TABLE 4-66
TOTAL U IN SURFACE SOILS IN AND AROUND THE FEMP*, 1984-1990

	Number of Samples	Range (pCi/g)	Arithmetic Mean	Standard Deviation
1984	55	1.08-68.50	7.23	10.29
1985	36	0.42-64.32	7.84	12.64
1986	24	1.42-46.37	5.14	8.86
1987	34	1.2-56.0	7.51	9.94
1988	27	1.4-73.0	7.43	13.69
1989	29	2.2-79.0	9.54	13.75
1990	30	1.1-41.0	6.53	7.19

*From annual EMR produced by NLO (1984) and WEMCO (1985-1990)

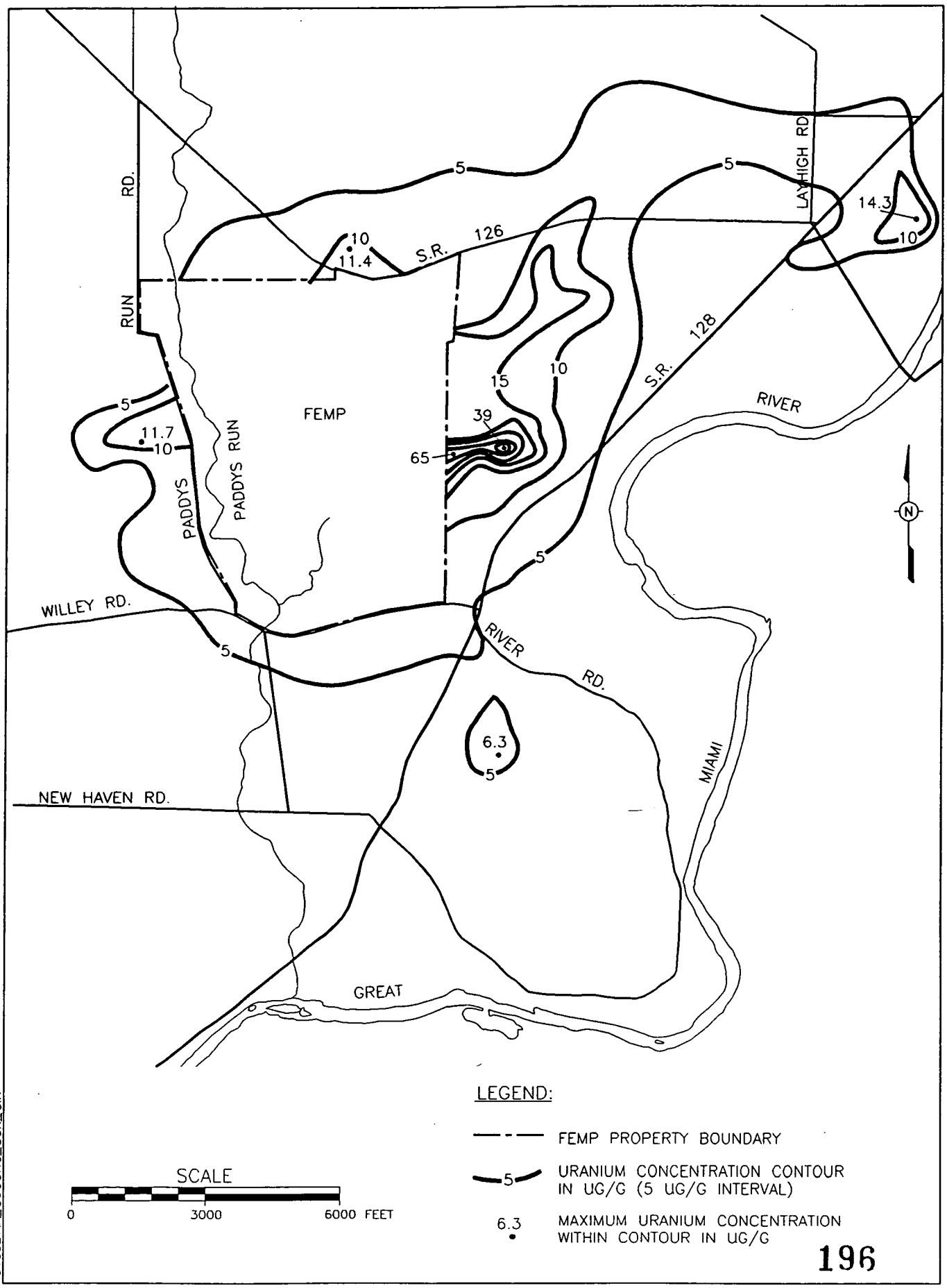


FIGURE 4-6 URANIUM CONCENTRATIONS IN SURFACE SOILS ADJACENT TO THE FEMP

of Ross (14.3 pCi/g) was caused by the large amount of cinder present in the sample. Coal typically contains higher amounts of uranium than would be found in ambient soil.

There were twenty-five additional samples analyzed for isotopes of thorium and plutonium, neptunium-237 and technetium-99 (Table 4-67). Plutonium isotopes and neptunium were not detected in any of the samples. Technetium-99 was detected in four samples ranging from 0.8 to 4 pCi/g. All three thorium isotopes were detected in all the soil samples.

4.1.5.3 Westinghouse Materials Company of Ohio, 1985 - 1990, "Feed Materials Production Center Environmental Monitoring Annual Report"

In 1985, the 15 samples collected from the same 1984 NLO locations were analyzed for total uranium only (Table 4-66), since analyses for other radionuclides in 1984 revealed small or undetectable concentrations of those radionuclides. Uranium concentrations ranged from 0.42 to 64.32 pCi/g. The highest levels were obtained near the former incinerator adjacent to the sewage treatment plant. 1985 concentrations were lower than those in 1984, but a strong correlation existed between the two years for samples collected at the same locations.

Uranium concentrations in 1986 samples from the 15 routine and 13 farm and garden produce locations ranged from 1.35 to 46.37 pCi/g (Table 4-66), and were generally higher than in 1985. Different laboratories were used to analyze the samples in 1985 and 1986, and may have accounted for the difference. Again, the highest levels were measured near the former incinerator.

In 1987, fourteen routine samples, along with twenty soil samples collected as part of the parallel soil and vegetation sampling, were collected with uranium concentrations ranging from 1.20 to 56.00 pCi/g (Table 4-66). All but two routine soil locations showed slightly higher uranium concentrations than in 1986. As was the case in the 1986 and 1985 data, a different laboratory was used to analyze uranium in soil, which may have accounted for the difference. The highest concentrations were again from the sampling location near the former incinerator.

Uranium concentrations ranged from 1.4 to 73.0 pCi/g in 1988 (Table 4-66), with the higher values near the former incinerator. All but three off-property sampling locations displayed uranium concentrations within the range considered background for Ohio (WMCO 1989).

The FEMP increased the number of samples to 30 in 1989 from 20 in 1988, with uranium concentrations ranging from 3.1 to 79.0 pCi/g for on-property samples, and 2.4 to 15.0 pCi/g in off-property samples (Table 4-66). The uranium concentrations in 11 of the off-property samples were above background, including one control sample (location 29, 15 miles SSE of the FEMP). When the sampling and analytical uncertainties were considered, the uranium concentrations in three of the remaining 10 locations were within background range.

TABLE 4-67
RADIONUCLIDES DETECTED DURING ADDITIONAL SURFACE SOIL SAMPLING (NLO, 1984)
TOTAL SAMPLES TAKEN = 25

Radionuclide	Range of Detection (pCi/g)	Mean (pCi/g)
Np-237	-	-
Pu-238	-	-
Pu-239/240	-	-
Tc-99	0.0-4.0	0.42
Th-228	0.3-1.6	0.97
Th-230	0.4-2.0	1.42
Th-232	0.4-1.7	1.02
Total U	1.4-11.8	4.86

In 1990, uranium concentrations in the on-property soil samples ranged from less than 2.9 to 41.0 pCi/g, while off-property samples ranged from 1.1 to 7.2 pCi/g (Table 4-66). There was a strong correlation between distance from the FEMP and the uranium concentration in the soil for the sector north to east-northeast of the FEMP. Although this sector represents only 20% of the circular area around the FEMP, it is downwind of the site over 35% of the time, based on wind rose data (Figure 2-5).

4.1.5.4 "Characterization Investigation Study," Volume 3, Weston (1987c)

Radiochemical separation was performed on surface samples from the waste storage area, the flyash piles, and the southfield. Most of the samples had above background radionuclide concentrations when measured at the on-site laboratory. They were selected in order to assess the isotopic concentrations of uranium and thorium, and to identify radionuclides not readily detectable by gamma-spectral techniques (i.e., strontium-90, technetium-99, lead-210, neptunium-210 and isotopes of plutonium).

Most of the samples taken from the waste storage area contained above background levels of depleted uranium, with uranium-238 as high as 3,490 pCi/g (Table 4-68). Thorium-230 was detected in all samples analyzed, in concentrations up to 972 pCi/g. Several samples contained measurable amounts of plutonium-238 and plutonium-239/240. Technetium-99 was encountered in half of the waste pit samples, whereas it was not detected in the flyash piles or the southfield. The highest technetium-99 concentration measured was 1540 pCi/g.

Several of the surface soil samples taken at the active flyash pile had detectable radium-226, thorium-232, and uranium-238, but uranium-238 was the only constituent that occurred in above background concentrations (Table 4-68). Samples taken in the inactive flyash pile contained above background concentrations of radium-226, thorium-230 and -232, uranium-234, -235, and -238. Notable is the positive detection of thorium-232 in samples from 0 to 18 inches but not in samples taken from 0 to 6 inches.

Numerous surface soil samples were taken in the southfield area. The highest concentrations of uranium-234, -235 and -238 in the 0 to 18 inch samples were 2,850 pCi/g, 356 pCi/g, and 2940 pCi/g, respectively. Other constituents detected included cesium-137, radium-226, thorium-230, and thorium-232. All of these radionuclides were found in concentrations exceeding background (Table 4-68).

4.1.5.5 "FMPC Sampling and Analysis Report," DOE (1988)

Concentrations of analytes in samples from the K-65 trench which exceed method detection limits (MDLs) are presented in Table 4-69. The maximum gamma emitting radionuclides were found in the sample from the east end of the trench. Uranium, thorium and cesium ranged from 0.24 pCi/g to 1.8 pCi/g. Radium-226 and its decay daughter Bi-214 had higher activities, 5.7 pCi/g each. Total

TABLE 4-68
RADIONUCLIDES DETECTED DURING CIS SURFACE SOIL SAMPLING

		Sampling Depth 0 - 6 in.				Sampling Depth 0 - 18 in.			
Radionuclide	Parameter	Waste Storage Area	Active Flyash Pile	Inactive Flyash Pile	South Field Area	Waste Storage Area	Active Flyash Pile	Inactive Flyash Pile	South Field Area
Cs-137	Frequency of Detection	38/452	ND	ND	21/224	41/451	ND	ND	21/305
	Range (pCi/g)	0.400-16.000	ND	ND	0.300-0.700	0.400-16.000	ND	ND	0.300-0.700
	Mean[a] (pCi/g)	0.425	ND	ND	0.432	0.407	ND	ND	0.423
Np-237	Frequency of Detection	1/41	ND	ND	ND	2/45	ND	ND	ND
	Range (pCi/g)	0.700-0.700	ND	ND	ND	0.700-4.600	ND	ND	ND
	Mean[a] (pCi/g)	0.091	ND	ND	ND	0.075	ND	ND	ND
Pu-238	Frequency of Detection	10/41	ND	ND	ND	13/45	ND	ND	ND
	Range (pCi/g)	0.000-0.700	ND	ND	ND	0.000-34.000	ND	ND	ND
	Mean[a] (pCi/g)	0.091	ND	ND	DN	0.100	ND	ND	ND
Pu-239/240	Frequency of Detection	11/41	ND	ND	ND	14/45	ND	ND	ND
	Range (pCi/g)	0.000-0.600	ND	ND	ND	0.000-8.600	ND	ND	ND
	Mean[a] (pCi/g)	0.106	ND	ND	ND	0.300	ND	ND	ND
Ra-226	Frequency of Detection	246/453	2/4	3/3	201/224	309/542	ND	7/7	265/305
	Range (pCi/g)	0.400-50.800	0.600-0.700	33.500-48.880	0.200-353.60	0.400-50.800	ND	1.700-48.880	0.200-353.60
	Mean[a] (pCi/g)	1.792	0.475	41.227	21.242	1.892	ND	25.740	21.587
Ru-106	Frequency of Detection	1/454	ND	ND	ND	1/543	ND	ND	1/305
	Range (pCi/g)	6.200-6.200	ND	ND	ND	6.200-6.200	ND	ND	14.600-14.600
	Mean[a] (pCi/g)	2.792	ND	ND	ND	2.908	ND	ND	2.970
Sr-90	Frequency of Detection	1/41	ND	ND	ND	1/45	ND	ND	ND
	Range (pCi/g)	1.500-1.500	ND	ND	ND	1.500-1.500	ND	ND	ND
	Mean[a] (pCi/g)	0.205	ND	ND	ND	0.213	ND	ND	ND

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TABLE 4-68 (Continued)

Radionuclide	Parameter	Sampling Depth 0 - 6 in.				Sampling Depth 0 - 18 in.			
		Waste Storage Area	Active Flyash Pile	Inactive Flyash Pile	South Field Area	Waste Storage Area	Active Flyash Pile	Inactive Flyash Pile	South Field Area
Tc-99	Frequency of Detection	22/41	ND	ND	ND	24/45	ND	ND	ND
	Range (pCi/g)	2.600-58.000	ND	ND	ND	2.600-1540.0	ND	ND	ND
	Mean[a] (pCi/g)	9.538	ND	ND	ND	15.171	ND	ND	ND
Th-228	Frequency of Detection	40/41	ND	ND	19/21	44/45	ND	ND	25/28
	Range (pCi/g)	0.100-48.000	ND	ND	0.100-39.000	0.100-61.000	ND	ND	0.100-129.00
	Mean[a] (pCi/g)	2.371	ND	ND	4.667	3.340	ND	ND	8.486
Th-230	Frequency of Detection	41/41	ND	1/1	21/21	45/45	ND	1/1	28/28
	Range (pCi/g)	0.100-972.00	ND	59.000-59.000[b]	0.200-164.00	0.100-972.00	ND	59.000-59.000[b]	0.200-2330.0
	Mean[a] (pCi/g)	25.734	ND		29.743	31.094	ND		145.35
Th-232	Frequency of Detection	344/454	4/4	ND	90/223	418/543	ND	2/7	126/304
	Range (pCi/g)	0.100-31.000	0.600-1.100	ND	0.100-70.200	0.10-170.00	ND	2.200-2.300	0.100-130.00
	Mean[a] (pCi/g)	2.292	0.800	ND	1.656	2.463	ND	1.957	1.719
U-234	Frequency of Detection	41/41	ND	1/1	21/21	45/45	ND	1/1	28/28
	Range (pCi/g)	1.700-241.00	ND	82.000-82.000[b]	4.200-2850.0	1.700-780.00	ND	82.000-82.000[b]	4.200-356.00
	Mean[a] (pCi/g)	83.984	ND		196.99	97.064	ND		15.282
U-235	Frequency of Detection	41/41	ND	1/1	21/21	45/45	ND	1/1	28/28
	Range (pCi/g)	0.100-33.000	ND	1.900-1.900[b]	0.200-356.00	0.100-81.000	ND	1.900-1.900[b]	0.200-356.00
	Mean[a] (pCi/g)	13.058	ND		19.576	14.518	ND		15.283
U-238	Frequency of Detection	434/454	2/4	1/3	97/224	521/543	ND	2/7	124/305
	Range (pCi/g)	2.500-2560.0	2.200-2.800	40.000-40.000	2.000-2940.0	2.500-3490.0	ND	5.200-40.000	2.000-2940
	Mean[a] (pCi/g)	214.29	3.825	21.783	12.382	198.59	ND	15.171	12.120

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TABLE 4-68 (Continued)

Radionuclide	Parameter	Sampling Depth 0 - 6 in.				Sampling Depth 0 - 18 in.			
		Waste Storage Area	Active Flyash Pile	Inactive Flyash Pile	South Field Area	Waste Storage Area	Active Flyash Pile	Inactive Flyash Pile	South Field Area

[a]If number of detects <7 or frequency of detection <50%, a geometric mean is given, otherwise, an arithmetic mean is given.
[b]Not applicable if sample size ≤2.

TAB[illegible]-69

ANALYTE CONCENTRATIONS WHICH EXCEED MINIMUM DETECTION LEVELS FOR SURFACE SOILS COLLECTED IN THE K-65 TRENCH (DOE, 1988)

		RCRA Metals	Radionuclides						
Sample Number	Location	Ba mg/L	U-235 pCi/g	Bi-214 pCi/g	Cs-137 pCi/g	Ra-226 pCi/g	Th-228 pCi/g	Th-232 pCi/g	Total U mg/kg
FEO1281S2B	K-65 Trench	0.53	0.11	0.9		0.88	1.1	1.4	15
FEO1291S2B	K-65 Trench	0.63	0.19	1.2		1.30	1.4	1.1	9.4
FEO1301S2B	K-65 Trench	0.54	0.23	1.2	0.13	1.30	1.4	1.6	12
FEO1311S2B	K-65 Trench	0.50	0.15	2.0		2.10	1.5	1.5	1.8
FEO1321S2B	K-65 Trench	0.55	0.42	5.7	0.24	5.70	1.8	1.7	12

		Organics		
Sample Number	Location	Acet µg/kg	ChlF µg/kg	M Chl µg/kg
FEO1281S3B	K-65 Trench	18 B	8	11 B
FEO1291S3B	K-65 Trench	18 B	9	18 B
FEO1301S3B	K-65 Trench	24 B	10	30 B
FEO1311S3B	K-65 Trench	24 B	11	12 B
FEO1321S3B	K-65 Trench	28 B	10	16 B

Footnotes and Flags

B = analyte was found in the blank as well as the sample.
Blank spaces indicate concentration below MDL.

Key to Organics Abbreviations

Acet--Acetone; ChlF--Chloroform; M Chl--Methylene Chloride

uranium on the north side of the trench ranged from 12 pCi/g to 15 pCi/g from the east end to the west end. Barium was the only RCRA metal found at higher than the analytical detection limit, with a peak value of 0.63 mg/ℓ.

Total uranium and certain radionuclides were encountered in both flyash piles and the southfield area (Table 4-70). The maximum of 58.0 mg/kg was recorded in the inactive flyash pile. The most common radionuclide was uranium-238, which was detected at all locations, with a sample from the inactive flyash pile exhibiting the highest value of 53 pCi/g. Volatile organic compounds were detected in fly ash samples from both the inactive and active flyash piles (Table 4-70), including methylene chloride, 1,1,1-trichloroethane, and acetone. Barium was the only RCRA metal which exceeded analytical detection limits in all samples from the flyash piles, with a range of 0.25 to 0.78 mg/ℓ.

Total uranium and other radionuclides were detected in soil samples from outside the former production area (Table 4-71). Uranium-238 was the most commonly encountered radionuclide, and samples collected from along the Burn Pit had the highest levels of both total U and uranium-238, 13,300 pCi/g and 9432 pCi/g, respectively. Acetone, chloroform, and methylene chloride were detected in all samples. Barium was detected in all samples, ranging from 0.28 to 1.47 mg/ℓ, while chromium was detected in samples from Waste Pit 4 and the fire training area (Table 4-71).

4.1.5.6 FEMP Remedial Investigation/Feasibility Study

Under the RI/FS program, surface soils were analyzed for 16 radionuclides (Section 3.1.5.6) (Table 4-72). Neptunium-237 and ruthenium-106 were not detected in any surface soil samples. Plutonium-238 was detected in 26 of 438 surface soil samples taken from 0 to 18 inches, while plutonium-239/240 occurred in 14 of 438 samples. The highest concentrations for all isotopes of plutonium occurred in the southwest quadrant of the former production area.

Total uranium was detected in all of the samples for which it was analyzed, ranging from 1.0 to 23,000 mg/kg. The highest concentrations occurred in the incinerator/sewage treatment area (Table 4-72). Isotopic uranium was analyzed in 461 surface soil samples from the 0 to 18-inch depth intervals. The mean concentration of uranium-238 detected was 104.8 pCi/g, and the highest concentrations were again detected in the incinerator/waste water treatment area. The highest concentration of uranium-234 (13,262 pCi/g) was detected in the southwest quadrant of the former production area (Table 4-72). The highest concentrations of uranium-235/236 were detected near the incinerator/sewage treatment plant area (Table 4-72).

Isotopic thorium was analyzed in 438 surface samples from the 0 to 18-inch depth interval (Table 4-72). Thorium-228 was detected in 421 of the samples, thorium-232 was found in 404 samples, and thorium-230 was detected in 436 samples. The highest concentrations of thorium-228 and Th-232 were

TABLE 4-70
ANALYTE CONCENTRATIONS WHICH EXCEED MINIMUM DETECTION LIMITS
SURFACE SOIL SAMPLES (DOE, 1988)

		RCRA Metals			Organics				
Sample Number	Location	Ba mg/L	Cr mg/L	1,1,1-Tri µg/kg	2-But µg/kg	Acet µg/kg	ChlF µg/kg	M Chl µg/kg	Tol µg/kg
FEO100WP2B	Active Flyash Pile	0.53 B		73		940 X		1100 X	34
FEO101WP2B	Active Flyash Pile	0.50 B				770 X		660 X	19
FEO102WP2B	Active Flyash Pile	0.55 B				580 X		480 X	
FEO103WP2B	Active Flyash Pile	0.78 B				280 X		350 X	
FEO104WP2B	Active Flyash Pile	0.25 B		190		170 X	7 B	260 X	89
FEO105WP2B	Active Flyash Pile	0.41 B				420 X	7 B	710 X	
FEO106WP2B	Active Flyash Pile	0.32 B				110 X		250 X	
FEO107WP2B	Active Flyash Pile	0.32 B				200 X	6 B	240 X	

		Radionuclides				
Sample Numbers	Location	Bi-214 pCi/g	Ra-226 pCi/g	Th-228 pCi/g	Th-232 pCi/g	Total U pCi/g
FEO100WP2B	Active Flyash Pile	3.9	3.8	2.7	2.7	9.1
FEO101WP2B	Active Flyash Pile	2.5	3.2	2.5	2.1	9.6
FEO102WP2B	Active Flyash Pile	4.0	2.9	2.5	1.0	10.0
FEO103WP2B	Active Flyash Pile	3.3	3.0	2.2	2.0	9.2
FEO104WP2B	Active Flyash Pile	2.7	3.1	2.9	2.2	9.7
FEO105WP2B	Active Flyash Pile	3.0	2.8	2.9	2.2	8.8
FEO106WP2B	Active Flyash Pile	3.1	2.7	2.7	2.9	13.0
FEO107WP2B	Active Flyash Pile	3.3	3.2	2.9	2.7	8.9

Footnotes and Flags
Blank spaces indicate concentration below MDL.
B = analyte was found in the blank as well as the sample.
X = flyash sample exhibited low internal standard recovery due to retention properties of matrix. Reported detection limits are for soil samples.
NS = sample not analyzed for indicated analyte.
Key to Organics Abbreviations
1,1,1-Tri-1,1,1-Trichloroethane; 2-But--2-Butanone; Acet--Acetone; ChlF--Chloroform; M Chl--Methylene Chloride; Tol--Toluene.

TABLE 4-[illegible] (Continued)

Sample Number	Location	RCRA Metals		Organics						
		Ba mg/L	Cr mg/L	2-But mg/kg	Acet mg/kg	ChlF mg/kg	M Chl mg/kg	Tol mg/kg	1,1,1-Tri µg/kg	1,1-Dicl µg/kg
FEO108SS3B	Inactive Flyash Pile	0.58 B			7 B		32	7 B		
FEO109SS3B	Inactive Flyash Pile	0.42 B					18 B			
FEO110SS3B	Inactive Flyash Pile	0.49 B		35	180 Q	10	280 Q	26		
FEO111SS3B	Inactive Flyash Pile	0.46 B		11 B	100 Q		100 Q	20		
FEO112SS3B	Inactive Flyash Pile	0.45 B		10 B	120Q		84 Q	13 B		
FEO113SS3B	Inactive Flyash Pile	0.55 B			24 B		42	10 B		
FEO114SS3B	Inactive Flyash Pile	0.47 B		10 B	21 B		30 B	6 B		
FEO115SS3B	Inactive Flyash Pile	0.55 B			16 B		51			

Sample Number	Location	Radionuclides							
		U-235 pCi/g	U-238 pCi/g	Bi-214 pCi/g	Cs-137 pCi/g	Ra-226 pCi/g	Th-228 pCi/g	Th-232 pCi/g	Total U mg/kg
FEO108SS3B	Inactive Flyash Pile		53.0	1.20	0.74	1.20	1.5	1.3	8.8
FEO109SS3B	Inactive Flyash Pile		37.0	1.20	0.74	1.20	1.5	1.3	57.0
FEO110SS3B	Inactive Flyash Pile			3.00		3.00	2.6	2.7	7.4
FEO111SS3B	Inactive Flyash Pile	0.16		1.20	0.07	1.20	1.0	1.1	4.8
FEO112SS3B	Inactive Flyash Pile	0.30	7.9	0.87	0.08	0.87	0.9	0.8	16.0
FEO113SS3B	Inactive Flyash Pile			1.00	0.44	0.89	1.2	1.0	9.7
FEO114SS3B	Inactive Flyash Pile			1.00		1.00	1.0	1.0	4.5
FEO115SS3B	Inactive Flyash Pile	0.79	29.0	0.92	0.24	0.85	1.1	1.1	58.0

Footnotes and Flags
B = analyte was found in the blank as well as the sample.
Q = data of questionable value. Possible laboratory contamination.

NS = sample not analzed for indicated analyte.
Blank spaces indicate concentration below MDL.

Key to Organics Abbreviations
2-But--2-Butanone; Acet--Acetone; Chlf--Chloroform; M Chl--Methylene Chloride; Tol--Toluene; 1,1,1-Tri--trichloroethane; 1,1-DiCl--1,1-Dichloroethane.

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TABLE 4-71
ANALYTE CONCENTRATIONS WHICH EXCEED MINIMUM DETECTION LIMITS
SURFACE SOIL SAMPLES (DOE, 1988)

		Radionuclides								RCRA Metals	
Sample Number	Location	U-235 pCi/g	U-238 pCi/g	Bi-214 pCi/g	Cs-137 pCi/g	Ra-226 pCi/g	Th-228 pCi/g	Th-232 pCi/g	Total U pCi/g	Ba mg/L	Cr mg/L
FEO123SS2B	Burn Pit Area	15.00	1873.0	1.90	1.50	2.00	2.80	2.10	3080.0	1.47	
FEO124SS2B	Burn Pit Area	61.00	9432.0	2.90		2.30	5.50	4.30	13300.0	0.64	
FEO125SS2B	Burn Pit Area	1.60	100.0	0.81		0.88	2.00	1.80	234.0	0.71	
FEO126SS2B	Cone House	0.14		0.94		0.80	1.10	1.30	4.3	0.43	
FEO127SS2B	Cone House			0.22		0.83	1.10	0.79	19.0	0.60	
FEO615SS2B	Fire Train. Area			0.32		0.31	0.37	0.38	27.0	0.58	0.05
FEO616SS2B	Lime Sludge Pond								14.0	0.36	0.05
FEO617SS2B	Lime Sludge Pond	0.18	1.6	0.40	0.27	0.38			19.0	0.28	0.04
FEO618SS2B	Lime Sludge Pond		41.0						36.0	0.29	0.04
FEO619SS2B	Lime Sludge Pond	0.44	22.0	0.27	0.21	0.27			28.0	0.29	0.03
FEO620SS2B	Sanitary Landfill	0.89	64.0	0.88		0.87	1.00	1.10	149.0	0.63	
FEO621SS2B	Sanitary Landfill			2.20		2.10	1.60	1.20	66.0	0.91	
FEO622SS2B	Sanitary Landfill	1.20	48.0	0.83		0.83	1.30	1.10	112.0	0.54	
FEO623SS2B	Sanitary Landfill	0.69		0.69		0.60	0.71	0.80	11.0	0.58	

Footnotes

Blank space indicates concentration below MDL.

TABLE 4-71 (Continued)

Sample Number	Location	Organics						
		Acet µg/kg	ChlF µg/kg	M Chl µg/kg	T-1,2-DCl µg/kg	1,1,1-Tri µg/kg	1,1 DiCl µg/kg	Tol µg/kg
FEO123SS3B	Burn Pit Area	64 B	15	20 B		111	11	
FEO124SS3B	Burn Pit Area	22 B	6	18 B		9	5	4 B
FEO125SS3B	Burn Pit Area	15 B	5	12 B				2 B
FEO126SS3B	Cone House	29 B	7	6				
FEO127SS3B	Cone House	16 B		4 B				
FEO615SS3B	Fire Train. Area	11 B	7	12 B		11		
FEO616SS3B	Lime Sludge Pond	18 B	7	8 B				
FEO617SS3B	Lime Sludge Pond	19 B	11	12 B		14		
FEO618SS3B	Lime Sludge Pond	21 B	7	14 B		9		
FEO619SS3B	Lime Sludge Pond	25 B	8	22 B		9		
FEO620SS3B	Sanitary Landfill	21 B	9	16 B		6		
FEO621SS3B	Sanitary Landfill	12 B	13	10 B		5		
FEO622SS3B	Sanitary Landfill	27 B	12	8 B				

Footnotes and Flags

Blank spaces indicate concentration below MDL.
B = analyte was found in the blank as well as the sample.

Key to Organics Abbreviations

Acet--Acetone; ChlF--Chloroform; M Chl--Methylene Chloride; 1,1-Tri--Trichloroethane; Tol--Toluene; T-1,2-DCl--Trans-1,2-Dichloroethene; 1,1-DiCl--1,1-Dichloroethane.

TABLE 4-72
RADIONUCLIDES DETECTED DURING RI/FS SURFACE SOIL SAMPLING

		Sampling Depth 0 - 6 in.				
Radionuclide	Parameters	Entire Site	NE Quadrant	NW Quadrant	SE Quadrant	SW Quadrant
Cs-137	Frequency of Detection	265/346	24/26	10/15	10/15	15/22
	Range (pCi/g)	0.200-14.400	0.200-0.800	0.200-0.800	0.300-14.400	0.200-2.900
	Mean[a] (pCi/g)	0.574	0.450	0.393	1.347	0.636
Pu-238	Frequency of Detection	14/346	ND	ND[e]	ND	9/22
	Range (pCi/g)	0.700-151.00	ND	ND	ND	0.700-151.00
	Mean[a] (pCi/g)	0.336	ND	ND	ND	1.279
Pu-239/240	Frequency of Detection	11/346	ND	ND	1/15	6/22
	Range (pCi/g)	1.100-12.900	ND	ND	1.100-1.100	0.700-12.900
	Mean[a] (pCi/g)	0.323	ND	ND	0.353	0.671
Ra-226	Frequency of Detection	295/346	25/26	15/15	15/15	16/22
	Range (pCi/g)	0.400-2950.0	0.600-9.000	0.600-2720.0	0.900-3.000	0.700-2.700
	Mean[a] (pCi/g)	18.670	1.860	188.13	1.487	1.245
Ra-228	Frequency of Detection	294/346	25/26	15/15	15/15	22/22
	Range (pCi/g)	0.500-558.00	0.700-558.00	0.500-56.200	0.700-5.400	0.700-546.00
	Mean[a] (pCi/g)	9.399	23.099	10.140	1.680	92.245
Sr-90	Frequency of Detection	156/344	6/26	4/15	2/15	10/22
	Range (pCi/g)	0.500-26.300	0.500-2.700	0.600-3.100	1.000-2.500	0.600-26.300
	Mean[a] (pCi/g)	0.868	0.458	0.408	0.450	0.637
Tc-99	Frequency of Detection	65/346	11/26	1/15	4/15	12/22
	Range (pCi/g)	0.900-320.00	0.900-2.600	2.500-2.500	1.000-2.000	1.100-320.00
	Mean[a] (pCi/g)	0.709	0.910	0.587	0.763	18.668

See footnotes at end of table.

TABLE 4-72 (Continued)

Radionuclide	Parameters	Sampling Depth 0 - 6 in.				
		Entire Site	NE Quadrant	NW Quadrant	SE Quadrant	SW Quadrant
Th-228	Frequency of Detection	334/346	25/26	15/15	15/15	22/22
	Range (pCi/g)	0.600-315.00	0.700-39.200	0.600-31.200	0.700-7.500	0.600-315.00
	Mean[a] (pCi/g)	4.651	3.219	5.453	1.947	42.132
Th-230	Frequency of Detection	344/346	26/26	15/15	15/15	22/22
	Range (pCi/g)	0.700-7901.0	1.300-7901.0	1.600-2729.0	1.000-40.300	1.200-288.00
	Mean[a] (pCi/g)	48.397	317.44	210.87	7.520	51.795
Th-232	Frequency of Detection	324/346	25/26	14/15	14/15	22/22
	Range (pCi/g)	0.600-283.00	0.600-194.00	0.600-31.400	0.700-9.100	0.600-283.00
	Mean[a] (pCi/g)	5.496	12.862	7.947	1.987	43.445
U-234	Frequency of Detection	370/371	26/26	15/15	15/15	22/22
	Range (pCi/g)	0.700-13262	4.200-7075.0	6.900-3857.0	4.000-970.00	5.200-13262
	Mean[a] (pCi/g)	58.428	300.01	354.13	124.68	1325.2
U-235/236	Frequency of Detection	176/371	24/26	12/15	9/15	20/22
	Range (pCi/g)	0.600-1730.0	0.700-69.900	0.700-204.00	0.700-41.600	0.700-950.00
	Mean[a] (pCi/g)	0.868	4.500	19.040	6.100	64.645
U-238	Frequency of Detection	370/371	26/26	15/15	15/15	22/22
	Range (pCi/g)	0.700-25670	4.800-7178.0	9.100-4108.0	4.400-986.00	5.400-14321
	Mean[a] (pCi/g)	72.015	308.41	390.55	135.91	1379.4
Uranium	Frequency of Detection	210/21-	23/23	9/9	14/14	19/19
	Range (mg/kg)	1.000-23000	12.000-217.000	25.000-140.00	17.000-3150.0	14.000-21100
	Mean[a] (mg/kg	216.47	91.217	67.889	490.93	1977.3

See footnotes at end of table.

TABLE 4-72 (Continued)

Radionuclide		Sampling Depth 0 - 18 in.				
		Entire Site	NE Quadrant	NW Quadrant	SE Quadrant	SW Quadrant
Cs-137	Frequency of Detection	278/438	27/50	12/31	11/23	17/44
	Range (pCi/g)	0.200-14.400	0.200-0.800	0.200-1.700	0.200-14.400	0.200-2.900
	Mean[a] (pCi/g)	0.485	0.305	0.382	0.246	0.389
Pu-238	Frequency of Detection	26/438	ND	1/31	1/23	17/44
	Range (pCi/g)	0.700-151.00	ND	0.900-0.900	1.700-1.700	0.700-151.00
	Mean[a] (pCi/g)	0.352	ND	0.319	0.361	1.068
Pu-239/240	Frequency of Detection	14/438	ND	ND	1/23	9/44
	Range (pCi/g)	0.700-12.900	ND	ND	1.100-1.100	0.700-12.900
	Mean[a] (pCi/g)	0.322	ND	ND	0.335	0.502
Ra-226	Frequency of Detection	385/438	48/50	31/31	23/23	37/44
	Range (pCi/g)	0.400-2950.0	0.600-9.000	0.600-2720.0	0.800-3.800	0.700-2.700
	Mean[a] (pCi/g)	21.959	1.488	189.84	1.474	1.187
Ra-228	Frequency of Detection	379/438	49/50	28/31	22/23	44/44
	Range (pCi/g)	0.500-558.00	0.700-558.00	0.500-56.200	0.700-5.400	0.700-546.00
	Mean[a] (pCi/g)	8.821	12.569	5.699	1.613	47.528
Sr-90	Frequency of Detection	200/436	21/50	9/31	5/23	17/44
	Range (pCi/g)	0.500-26.300	0.500-3.600	0.500-3.100	0.500-2.500	0.600-26.300
	Mean[a] (pCi/g)	0.846	0.502	0.516	0.439	0.517
Tc-99	Frequency of Detection	92/438	20/50	3/31	7/23	18/44
	Range (pCi/g)	0.900-320.00	0.900-8.100	1.000-2.500	1.000-5.500	1.100-320.00
	Mean[a] (pCi/g)	0.739	0.863	0.565	0.763	1.245

See footnotes at end of table.

TABLE 4-72 (Continued)

Radionuclide		Sampling Depth 0 - 18 in.				
		Entire Site	NE Quadrant	NW Quadrant	SE Quadrant	SW Quadrant
Th-228	Frequency of Detection	421/438	49/50	29/31	22/23	44/44
	Range (pCi/g)	0.600-315.00	0.600-39.200	0.600-31.200	0.700-7.500	0.600-315.00
	Mean[a] (pCi/g)	4.717	1.779	4.253	1.852	23.690
Th-230	Frequency of Detection	436/438	50/50	31/31	23/23	44/44
	Range (pCi/g)	0.700-7901.0	1.000-7901.0	0.800-2749.0	1.000-275.00	1.200-288.00
	Mean[a] (pCi/g)	50.194	166.49	208.42	17.826	27.001
Th-232	Frequency of Detection	404/438	44/50	27/31	22/23	42/44
	Range (pCi/g)	0.600-283.00	0.600-194.00	0.600-31.400	0.600-9.100	0.600-283.00
	Mean[a] (pCi/g)	5.284	7.184	5.507	1.965	29.993
U-234	Frequency of Detection	460/461	50/50	31/31	23/23	44/44
	Range (pCi/g)	0.700-13262	3.100-7075.0	5.800-3857.0	3.700-970.00	5.200-13262
	Mean[a] (pCi/g)	80.350	52.960	173.70	118.07	673.39
U-235/236	Frequency of Detection	248/461	41/50	26/31	14/23	42/44
	Range (pCi/g)	0.600-1730.0	0.700-69.900	0.600-204.00	0.700-41.600	0.700-950.00
	Mean[a] (pCi/g)	3.941	2.549	8.725	6.109	31.861
U-238	Frequency of Detection	460/461	50/50	31/31	23/23	44/44
	Range (pCi/g)	0.700-25670	3.100-7178.0	7.400-4108.0	3.900-986.00	5.400-14321
	Mean[a] (pCi/g)	104.78	61.063	222.52	131.22	710.18
Uranium	Frequency of Detection	302/302	47/47	25/25	22/22	41/41
	Range (pCi/g)	1.000-23000	9.000-2270.0	19.000-6140.0	9.000-3150.0	14.000-21100
	Mean[a] (pCi/g)	324.39	107.31	446.68	427.59	1133.6

See footnotes at end of table.

TABLE 4-72 (Continued)

Radionuclide		0 - 6 in.					0 - 18 in.	
		Incinerator/Waste Water Treatment Facility	Silo Area	Waste Storage Area (0 - 2 in.)	Flyash/ South Field Area (0 - 2 in.)	Remainder of the Site	Incinertor/Waste WaterTreatment Facility	Remainder of the Site
Cs-137	Frequency of Detection	22/32	ND	1/9	2/2	181/218	25/40	183/232
	Range (pCi/g)	0.300-1.100	ND	0.200-0.200	0.300-0.700	0.200-1.600	0.200-1.100	0.200-1.600
	Mean[a] (pCi/g)	0.527	ND	0.111	[b]	0.573	0.454	0.545
Pu-238	Frequency of Detection	2/32	ND	ND	ND	3/218	4/40	3/232
	Range (pCi/g)	1.400-1.500	ND	ND	ND	0.900-2.200	1.400-2.400	0.900-2.200
	Mean[a] (pCi/g)	0.372	ND	ND	ND	0.316	0.445	0.315
Pu-239/240	Frequency of Detection	2/32	ND	ND	ND	2/218	2/40	2/232
	Range (pCi/g)	1.100-1.500	ND	ND	ND	1.900-2.900	1.100-1.500	1.900-2.900
	Mean[a] (pCi/g)	0.363	ND	ND	ND	0.319	0.350	0.318
Ra-226	Frequency of Detection	29/32	7/7	7/9	2/2	179/218	37/40	193/232
	Range (pCi/g)	0.900-188.00	1.000-4.200	0.700-1.200	1.200-1.400	0.400-2950.0	1.900-188.00	0.400-2950.0
	Mean[a] (pCi/g)	11.628	1.700	0.739	[b]	14.434	9.720	13.624
Ra-228	Frequency of Detection	26/32	7/7	7/9	ND	177/218	34/40	188/232
	Range (pCi/g)	0.600-18.000	1.000-1.700	0.500-1.800	ND	0.500-45.500	0.600-18.000	0.500-45.500
	Mean[a] (pCi/g)	2.818	1.314	0.894	ND	1.496	2.877	1.650
Sr-90	Frequency of Detection	25/32	6/7	3/9	ND	100/216	30/40	109/230
	Range (pCi/g)	0.500-3.700	0.800-2.600	0.500-0.900	ND	0.500-6.500	0.500-3.900	0.500-6.500
	Mean[a] (pCi/g)	1.264	1.136	0.389	ND	0.793	1.206	0.788

See footnotes at end of table.

TABLE 4-72 (Continued)

Radionuclide		0 - 6 in.					0 - 18 in.	
		Incinerator/Waste Water Treatment Facility	Silo Area	Waste Storage Area (0 - 2 in.)	Flyash/ South Field Area (0 - 2 in.)	Remainder of the Site	Incinertor/Waste WaterTreatment Facility	Remainder of the Site
Tc-99	Frequency of Detection	14/32	1/7	1/9	ND	21/218	20/40	22/232
	Range (pCi/g)	1.000-228.00	1.200-1.200	0.900-0.900	ND	0.900-27.300	1.000-228.00	0.900-27.300
	Mean[a] (pCi/g)	1.686	0.571	0.500	ND	0.595	6.824	1.033
Th-228	Frequency of Detection	31/32	7/7	9/9	2/2	208/218	39/40	220/232
	Range (pCi/g)	0.700-24.800	0.900-1.400	0.800-2.200	0.900-0.900	0.600-38.900	0.700-24.800	0.600-38.900
	Mean[a] (pCi/g)	3.099	1.100	1.222	[b]	1.629	3.153	1.525
Th-230	Frequency of Detection	32/32	7/7	9/9	2/2	216/218	40/40	230/232
	Range (pCi/g)	1.200-806.00	1.900-4.300	1.500-6.100	1.500-5.300	0.700-1137.0	1.200-806.00	0.700-1137.0
	Mean[a] (pCi/g)	49.845	3.057	2.811	[b]	7.721	77.462	7.493
Th-232	Frequency of Detection	32/32	7/7	9/9	2/2	199/218	40/40	211/232
	Range (pCi/g)	0.600-61.900	0.900-1.700	0.600-1.400	1.700-1.800	0.600-11.400	0.600-61.900	0.600-11.400
	Mean[a] (pCi/g)	3.898	1.171	0.944	[b]	1.187	3.907	1.191
U-234	Frequency of Detection	32/32	4/4	9/9	2/2	245/246	38/38	259/260
	Range (pCi/g)	3.700-10977	2.400-6.900	1.000-5.300	2.600-5.100	0.700-2899.0	3.700-10977	0.700-2899.0
	Mean[a] (pCi/g)	1399.4	4.125	3.000	[b]	11.614	1539.7	24.362

See footnotes at end of table.

TABLE 4-72 (Continued)

Radionuclide		0 - 6 in.					0 - 18 in.	
		Incinerator/Waste Water Treatment Facility	Silo Area	Waste Storage Area (0 - 2 in.)	Flyash/ South Field Area (0 - 2 in.)	Remainder of the Site	Incinertor/Waste WaterTreatment Facility	Remainder of the Site
U-235/236	Frequency of Detection	28/32	ND	1/9	ND	82/246	34/38	90/260
	Range (pCi/g)	0.600-1730.0	ND	0.800-0.800	ND	0.600-49.300	0.600-1730.0	0.600-49.300
	Mean[a] (pCi/g)	102.37	ND	0.356	ND	0.506	105.07	1.108
U-238	Frequency of Detection	32/32	4/4	9/9	2/2	245/246	38/38	259/260
	Range (pCi/g)	4.100-25670	2.400-20.800	1.500-16.100	2.700-4.900	0.700-1849.0	4.100-25670	0.700-1849.0
	Mean[a] (pCi/g)	1777.9	6.467	7.333	[b]	15.552	1913.4	19.935
Uranium	Frequency of Detection	22/22	7/7	7/7	ND	109/109	30.30	123/123
	Range (mg/kg)	12.000-23000	4.000-64.000	3.000-62.000	ND	1.000-1180.0	12.000-23000	1.000-1790.0
	Mean[a] (mg/kg)	2393.9	21,571	28.429	ND	54.629	2075.3	87.161

[a]If number of detects <7 or frequency of detection <50%, a geometric mean is given; otherwise, an arithmetic mean is given.
[b]Not applicable if sample size ≤2.
[c]Not detected.

encountered in the southwest quadrant of the former production area, while the highest thorium-230 concentrations occurred in the northeast quadrant.

Four hundred thirty-eight surface soil samples were analyzed for radium-226 and Ra-228. The highest concentration of radium-226 was 2,950 pCi/g, while radium-228 was detected in 379 soil samples with a maximum concentration of 558 pCi/g (Table 4-72). The highest concentration of radium-228 was detected in the northeast quadrant of the former production area.

Strontium-90 was detected in 200 of 436 samples that were analyzed in 0 to 18 inch surface soils (Table 4-72). The highest concentrations were in the southwest quadrant of the former production area. Cesium-137 was detected in 278 of 438 near surface soil samples, with a maximum concentration of 14.4 pCi/g in the southeast quadrant of the former production area. The highest detections of technetium-99 were also found in the southwest quadrant of the former production area.

HSL inorganic analysis was conducted on a total of 101 surface soil samples from the entire site. Constituents detected in all samples taken included aluminum, arsenic, barium, beryllium, cadmium, calcium, cobalt, copper, iron, magnesium, nickel, vanadium, and zinc (Table 4-73A). The highest concentrations of inorganics were generally found in the former production area with lower values for the remainder of the FEMP. (Data for the southeast quadrant were not available as of the December 1, 1991 SWCR data cutoff date.)

Forty-seven volatile and semivolatile organics were detected in surface samples from the FEMP (Table 4-73B). PCBs were encountered in all samples it was analyzed for, as was benzo(a)pyrene and methylene chloride. The highest concentrations of forty-one of these chemical constituents were found in samples from the northeast quadrant of the former production area (Table 4-73B).

TABLE 4-73A
INORGANIC CHEMICALS DETECTED DURING RI/FS SURFACE SOIL SAMPLING

		Sampling Depth 0 - 6 in.						
Chemical	Parameters	Entire Site	NE Quadrant	NW Quadrant	SW Quadrant	Remainder of the Site	Waste Storage Area	Silo Area
Aluminum	Frequency of Detection	60/60	6/6	13/13	5/5	17/17	16/16	3/3
	Range (mg/kg)	9.560-16500	2230.0-11900	5860.0-16500	9.560-11900	4690.0-12900	2580.0-11700	8770.0-10900
	Mean[a] (mg/kg)	7938.5	6360.0	10827	6613.9	8301.8	5845.6	9890.0
Antimony	Frequency of Detection	50/60	1/6	13/13	ND[b]	17/17	16/16	3/3
	Range (mg/kg)	9.700-35.200	9.700-9.700	22.000-35.200	ND	12.800-32.300	19.600-32.500	20.600-29.700
	Mean[a] (mg/kg)	22.279	4.217	29.462	ND	25.200	25.513	26.300
Arsenic	Frequency of Detection	60/60	6/6	13/13	5/5	17/17	16/16	3/3
	Range (mg/kg)	2.700-32.500	4.100-22.600	4.000-10.800	5.700-8.400	3.600-32.500	2.800-6.400	2.700-9.500
	Mean[a] (mg/kg)	6.466	8.800	6.677	6.820	7.665	4.463	7.067
Barium	Frequency of Detection	60/60	6/6	13/13	5/5	17/17	16/16	3/3
	Range (mg/kg)	0.096-1570.0	34.900-512.00	50.600-1570.0	0.096-561.00	40.500-99.200	22.500-92.300	67.300-113.00
	Mean[a] (mg/kg)	141.14	240.13	203.82	272.74	64.324	49.100	85.167
Beryllium	Frequency of Detection	60/60	6/6	13/13	5/5	17/17	16/16	3/3
	Range (mg/kg)	0.002-2.400	0.980-1.800	0.680-1.100	0.002-2.400	0.530-0.890	0.580-1.000	0.700-1.000
	Mean[a] (mg/kg)	0.874	1.313	0.941	1.200	0.744	0.705	0.800
Cadmium	Frequency of Detection	60/60	6/6	13/13	5/5	17/17	16/16	3/3
	Range (mg/kg)	0.003-8.000	3.500-8.000	3.600-6.700	0.003-6.900	2.300-6.200	3.200-7.700	3.700-4.900
	Mean[a] (mg/kg)	4.877	5.417	5.015	4.101	4.576	5.206	4.433
Calcium	Frequency of Detection	60/60	6/6	13/13	5/5	17/17	16/16	3/3
	Range (mg/kg)	35.200-181000	21000-178000	24100-106000	35.200-181000	13500-123000	21000-155000	23300-131000
	Mean[a] (mg/kg)	76456	105050	61777	76295	59753	98081	62467

See footnotes at end of table.

Table 4-73A (Continued)

		Sampling Depth 0 - 6 in.						
Chromium	Frequency of Detection	60/60	6/6	13/13	5/5	17/17	16/16	3/3
	Range (mg/kg)	0.024-75.500	12.700-50.400	12.400-26.200	0.024-75.500	10.200-21.600	5.900-18.800	15.800-22.600
	Mean[a] (mg/kg)	18.660	29.600	20.754	27.165	16.629	12.413	18.367
Cobalt	Frequency of Detection	60/60	6/6	13/13	5/5	17/17	16/16	3/3
	Range (mg/kg)	0.014-44.900	7.800-15.700	9.400-44.900	0.014-17.400	7.500-13.200	6.500-17.000	10.000-14.800
	Mean[a] (mg/kg)	11.757	11.983	16.577	12.323	10.071	9.250	12.400
Copper	Frequency of Detection	60/60	6/6	13/13	5/5	17/17	16/16	3/3
	Range (mg/kg)	0.270-859.00	13.800-65.200	16.400-859.00	0.027-38.500	13.200-26.900	11.400-20.100	18.200-23.500
	Mean[a] (mg/kg)	34.835	28.350	91.031	21.145	18.524	15.881	20.633
Cyanide	Frequency of Detection	15/59	2/5	5/13	1/5	3/17	4/16	ND
	Range (mg/kg)	0.120-22.800	0.590-22.800	0.160-1.000	0.520-0.520	0.120-0.260	0.370-0.710	
	Mean[a] (mg/kg)	0.112	4.747	0.129	0.218	0.082	0.100	
Iron	Frequency of Detection	60/60	6/6	13/13	5/5	17/17	16/16	3/3
	Range (mg/kg)	19.100-30300	8460.0-26900	12800-30300	19.100-27300	11100-25300	6670.0-23800	19200-26300
	Mean[a] (mg/kg)	17397	17322	21854	15600	17506	13395	21967
Lead	Frequency of Detection	57/59	6/6	13/13	3/4	16/17	16/16	3/3
	Range (mg/kg)	6.700-334.00	11.700-182.00	7.400-73.500	30.300-334.00	8.700-29.700	6.800-34.300	6.700-17.000
	Mean[a] (mg/kg)	32.970	67.550	34.723	120.38	14.873	12.738	11.500
Magnesium	Frequency of Detection	60/60	6/6	13/13	5/5	17/17	16/16	3/3
	Range (mg/kg)	9.740-46000	6710.0-46000	8580.0-37800	9.740-38600	5210.0-26800	6370.0-39000	10800-15400
	Mean[a] (mg/kg)	19447	28235	18468	14982	16999	22051	13533
Manganese	Frequency of Detection	59/60	6/6	13/13	4/5	17/17	16/16	3/3
	Range (mg/kg)	0.835-1130.0	335.00-552.00	412.00-732.00	0.835-811.00	346.00-602.00	317.00-759.00	498.00-1130.0
	Mean[a] (mg/kg)	501.22	447.17	565.85	307.41	479.24	512.50	716.67

See footnotes at end of table.

Table 4-73A (Continued)

		Sampling Depth 0 - 6 in.						
Mercury	Frequency of Detection	11/60	4/6	2/13	5/5	ND	ND	ND
	Range (mg/kg)	0.160-1.300	0.220-0.530	0.160-0.200	0.340-1.300	ND	ND	ND
	Mean[a] (mg/kg)	0.124	0.243	0.076	0.582	ND	ND	ND
Molybdenum	Frequency of Detection	48/60	2/6	13/13	1/5	14/17	15/16	3/3
	Range (mg/kg)	2.700-5.700	4.700-5.700	2.900-4.900	2.900-2.900	2.700-5.200	3.000-5.700	3.200-4.700
	Mean[a] (mg/kg)	3.483	2.425	3.862	1.230	3.753	3.922	3.833
Nickel	Frequency of Detection	60/60	6/6	13/13	5/5	17/17	16/16	3/3
	Range (mg/kg)	0.040-67.800	22.300-67.800	25.100-57.000	0.040-50.000	16.300-41.300	19.700-50.200	23.200-38.900
	Mean[a] (mg/kg)	30.322	44.433	33.223	32.148	26.382	26.219	30.700
Potassium	Frequency of Detection	60/60	6/6	13/13	5/5	17/17	16/16	3/3
	Range (mg/kg)	434.00-2470.0	435.00-1670.0	714.00-2300.0	856.00-2470.0	530.00-1110.0	434.00-1210.0	949.00-1430.0
	Mean[a] (mg/kg)	1013.9	944.17	1256.6	1425.0	894.29	817.69	1156.3
Selenium	Frequency of Detection	3/60	ND	ND	ND	ND	2/16	1/3
	Range (mg/kg)	0.540-0.620	ND	ND	ND	ND	0.540-0.620	0.540-0.540
	Mean[a] (mg/kg)	0.247	ND	ND	ND	ND	0.275	0.343
Silver	Frequency of Detection	55/60	4/6	13/13	2/5	17/17	16/16	3/3
	Range (mg/kg)	0.003-17.200	2.900-4.400	6.700-10.000	0.003-17.200	4.600-10.400	5.800-10.300	6.600-8.400
	Mean[a] (mg/kg)	7.268	2.717	8.246	4.091	8.076	8.294	7.367
Sodium	Frequency of Detection	59/59	6/6	13/13	5/5	17/17	15/15	3/3
	Range (mg/kg)	0.150-2180.0	182.00-2000.0	73.800-259.00	0.150-2180.0	42.700-145.00	54.600-185.00	86.200-119.00
	Mean[a] (mg/kg)	281.90	896.33	134.72	1142.0	95.759	124.09	101.03
Thallium	Frequency of Detection	10/60	2/6	4/13	2/5	1/17	1/16	ND
	Range (mg/kg)	0.330-1.100	0.420-0.570	0.520-1.100	0.330-0.360	0.510-0.510	0.680-0.680	ND
	Mean[a] (mg/kg)	0.279	0.253	0.382	0.224	0.252	0.259	ND

See footnotes at end of table.

Table 4-73A (Continued)

		Sampling Depth 0 - 6 in.						
Vanadium	Frequency of Detection	60/60	6/6	13/13	5/5	17/17	16/16	3/3
	Range (mg/kg)	0.027-35.800	15.200-29.500	17.800-35.800	0.027-35.600	15.900-29.400	10.900-26.900	23.700-27.700
	Mean[a] (mg/kg)	22.174	21.883	27.492	19.865	22.747	17.519	25.133
Zinc	Frequency of Detection	60/60	6/6	13/13	5/5	17/17	16/16	3/3
	Range (mg/kg)	0.061-431.00	24.200-431.00	37.200-180.00	0.061-328.00	32.900-79.500	21.900-79.900	45.400-65.200
	Mean[a] (mg/kg)	81.964	220.87	74.977	200.21	47.918	40.150	53.300
		Sampling Depth 0 - 18 in.						
Aluminum	Frequency of Detection	101/101	39/39	15/15	10/10	18/18	16/16	3/3
	Range (mg/kg)	9.530-16500	955.00-14800	5860.0-16500	9.530-12400	4690.0-12900	2580.0-11700	8770.0-10900
	Mean[a] (mg/kg)	7711.2	7010.9	10831	6690.9	8490.6	5845.6	9890.0
Antimony	Frequency of Detection	72/101	22/39	13/15	ND	18/18	16/16	3/3
	Range (mg/kg)	6.600-35.200	6.600-19.200	22.000-35.200	ND	10.300-32.300	19.600-32.500	20.600-29.700
	Mean[a] (mg/kg)	16.500	8.368	25.920	ND	24.372	25.513	26.300
Arsenic	Frequency of Detection	101/101	39/39	15/15	10/10	18/18	16/16	3/3
	Range (mg/kg)	0.020-81.900	0.020-81.900	3.900-10.800	3.900-8.400	2.600-32.500	2.800-6.400	2.700-9.500
	Mean[a] (mg/kg)	7.027	8.347	6.433	6.220	7.383	4.463	7.067
Barium	Frequency of Detection	101/101	39/39	15/15	10/10	18/18	16/16	3/3
	Range (mg/kg)	0.089-1570.0	11.200-523.00	50.600-1570.0	0.089-587.00	40.500-105.00	22.500-92.300	67.300-113.00
	Mean[a] (mg/kg)	122.43	111.00	189.13	273.68	66.583	49.100	85.167
Beryllium	Frequency of Detection	101/101	39/39	15/15	10/10	18/18	16/16	3/3
	Range (mg/kg)	0.002-2.400	0.570-1.900	0.680-1.400	0.002-2.400	0.530-0.900	0.580-1.000	0.700-1.000
	Mean[a] (mg/kg)	0.929	1.058	0.975	1.066	0.753	0.705	0.800

See footnotes at end of table.

Table 4-73A (Continued)

		Sampling Depth 0 - 18 in.						
Cadmium	Frequency of Detection	101/101	39/39	15/15	10/10	18/18	16/16	3/3
	Range (mg/kg)	0.003-8.000	1.900-8.000	3.600-6.700	0.003-6.900	2.000-6.200	3.200-7.700	3.700-4.900
	Mean[a] (mg/kg)	4.474	4.241	4.907	3.701	4.433	5.206	4.433
Calcium	Frequency of Detection	101/101	39/39	15/15	10/10	18/18	16/16	3/3
	Range (mg/kg)	35.200-260000	5040.0-260000	24100-106000	35.200-181000	5410.0-123000	21000-155000	23300-131000
	Mean[a] (mg/kg)	79361	93445	60960	67883	56734	98081	62467
Chromium	Frequency of Detection	100/101	38/39	15/15	10/10	18/18	16/16	3/3
	Range (mg/kg)	0.023-94.600	5.500-94.600	12.400-26.200	0.023-75.500	10.200-21.600	5.900-18.800	15.800-22.600
	Mean[a] (mg/kg)	19.615	23.288	20.907	24.135	16.683	12.413	18.367
Cobalt	Frequency of Detection	101/101	39/39	15/15	10/10	18/18	16/16	3/3
	Range (mg/kg)	0.014-59.500	6.200-59.500	9.400-44.900	0.014-17.400	7.500-13.200	6.500-17.000	10.000-14.800
	Mean[a] (mg/kg)	11.765	11.628	16.473	10.923	10.044	9.250	12.400
Copper	Frequency of Detection	101/101	39/39	15/15	10/10	18/18	16/16	3/3
	Range (mg/kg)	0.022-859.00	7.500-65.200	16.400-859.00	0.022-69.400	13.200-26.900	11.400-20.100	18.200-23.500
	Mean[a] (mg/kg)	28.995	21.293	81.280	22.905	18.322	15.881	20.633
Cyanide	Frequency of Detection	24/99	11/37	5/15	1/10	3/18	4/16	ND
	Range (mg/kg)	0.120-22.800	0.120-22.800	0.160-1.000	0.520-0.520	0.120-0.260	0.370-0.710	ND
	Mean[a] (mg/kg)	0.111	0.128	0.131	0.182	0.081	0.179	ND
Iron	Frequency of Detection	101/101	39/39	15/15	10/10	18/18	16/16	3/3
	Range (mg/kg)	18.100-41800	3030.0-41800	12800-30300	18.100-27300	11100-25300	6670.0-23800	19200-26300
	Mean[a] (mg/kg)	17669	18122	21987	14710	17817	13395	21967
Lead	Frequency of Detection	98/100	39/39	15/15	8/9	17/18	16/16	3/3
	Range (mg/kg)	0.040-440.00	0.040-182.00	7.400-73.500	15.500-440.00	8.700-29.700	6.800-34.300	6.700-17.000
	Mean[a] (mg/kg)	31.607	29.697	31.860	113.55	14.685	12.738	11.500

Table 4-73A (Continued)

		Sampling Depth 0 - 18 in.						
Magnesium	Frequency of Detection	101/101	39/39	15/15	10/10	18/18	16/16	3/3
	Range (mg/kg)	9.740-55100	1620.0-55100	8330.0-37800	9.740-38600	2970.0-26800	6370.0-39000	10800-15400
	Mean[a] (mg/kg)	19354	22007	17967	14162	16219	22051	13533
Manganese	Frequency of Detection	100/101	39/39	15/15	9/10	18/18	16/16	3/3
	Range (mg/kg)	0.614-1130.0	94.600-818.00	412.00-762.00	0.614-811.00	346.00-602.00	317.00-759.00	498.00-1130.0
	Mean[a] (mg/kg)	479.44	454.89	579.60	299.37	480.28	512.50	716.67
Mercury	Frequency of Detection	23/100	11/39	3/15	9/9	ND	ND	ND
	Range (mg/kg)	0.160-1.900	0.170-0.530	0.160-1.900	0.270-1.300	ND	ND	ND
	Mean[a] (mg/kg)	0.084	0.116	0.080	0.598	ND	ND	ND
Molybdenum	Frequency of Detection	68/99	22/38	13/14	1/10	14/18	15/16	3/3
	Range (mg/kg)	2.500-6.200	2.500-6.200	2.900-4.900	2.900-2.900	2.700-5.200	3.000-5.700	3.200-4.700
	Mean[a] (mg/kg)	3.091	2.767	3.664	1.035	3.608	3.922	3.833
Nickel	Frequency of Detection	101/101	39/39	15/15	10/10	18/18	16/16	3/3
	Range (mg/kg)	0.040-102.00	16.200-102.00	25.100-57.000	0.040-50.000	16.300-41.300	19.700-50.200	23.200-38.900
	Mean[a] (mg/kg)	30.349	31.990	34.013	31.508	25.889	26.219	30.700
Potassium	Frequency of Detection	100/101	38/39	15/15	10/10	18/18	16/16	3/3
	Range (mg/kg)	206.00-2470.0	206.00-1670.0	714.00-2300.0	571.00-2470.0	530.00-1110.0	434.00-1210.0	949.00-1430.0
	Mean[a] (mg/kg)	1028.4	850.61	1247.0	1249.2	888.22	817.69	1156.3
Selenium	Frequency of Detection	10/101	7/39	ND	ND	ND	2/16	1/3
	Range (mg/kg)	0.480-7.700	0.480-7.700	ND	ND	ND	0.540-0.620	0.540-0.540
	Mean[a] (mg/kg)	0.260	0.299	ND	ND	ND	0.275	0.343
Silver	Frequency of Detection	83.101	26/39	14/15	6/10	18/18	16/16	3/3
	Range (mg/kg)	0.003-17.200	2.700-7.500	2.900-10.000	0.003-17.200	2.400-10.400	5.800-10.300	6.600-8.400
	Mean[a] (mg/kg)	5.733	3.541	7.413	0.632	7.761	8.294	7.367

See footnotes at end of table.

Table 4-73A (Continued)

		Sampling Depth 0 - 18 in.						
Sodium	Frequency of Detection	100/100	39/39	15/15	10/10	18/18	15/15	3/3
	Range (mg/kg)	0.150-2220.0	69.600-2000.0	73.800-316.00	0.150-2220.0	42.700-145.00	54.600-185.00	86.200-119.00
	Mean[a] (mg/kg)	328.74	347.39	144.36	1173.0	93.128	124.09	101.03
Thallium	Frequency of Detection	17/101	6/39	4/15	5/10	1/18	1/16	ND
	Range (mg/kg)	0.260-1.100	0.340-0.600	0.520-1.100	0.260-0.360	0.510-0.510	0.680-0.680	ND
	Mean[a] (mg/kg)	0.255	0.226	0.351	0.231	0.252	0.259	ND
Vanadium	Frequency of Detection	101/101	39/39	15/15	10/10	18/18	16/16	3/3
	Range (mg/kg)	0.027-35.800	8.400-30.500	17.800-35.800	0.027-35.600	15.900-29.400	10.900-26.900	23.700-27.700
	Mean[a] (mg/kg)	21.382	20.531	26.733	18.955	22.922	17.519	25.133
Zinc	Frequency of Detection	101/101	39/39	15/15	10/10	18/18	16/16	3/3
	Range (mg/kg)	0.043-431.00	11.100-431.00	37.200-180.00	0.043-383.00	32.900-79.500	21.900-79.900	45.400-65.200
	Mean[a] (mg/kg)	84.012	95.252	72.693	192.51	48.017	40.150	53.300

[a]If number of detects <7 or frequency of detection <50%, a geometric mean is given, otherwise, an arithmetic mean is given.
[b]--, not detected.

See footnotes at end of table.

TABLE 4-73B
ORGANIC CHEMICALS DETECTED DURING RI/FS SURFACE SOIL SAMPLING

Chemical	Parameters	Sampling Depth 0 - 6 in.						
		Entire Site	NE Quadrant	NW Quadrant	SW Quadrant	Remainder of the Site	Waste Storage Area	Silo Area
1,1,1-tri-chloroethane	Frequency of Detection	1/12	1/6	ND[c]	ND	ND	ND	ND
	Range (mg/kg)	0.007-0.007	0.007-0.007	ND	ND	ND	ND	ND
	Mean[a] (mg/kg)	0.003	0.003	ND	ND	ND	ND	ND
1,2-di-chloroetheylene	Frequency of Detection	1/12	1/6	ND	ND	ND	ND	ND
	Range (mg/kg)	0.001-0.001	0.001-0.001	ND	ND	ND	ND	ND
	Mean[a] (mg/kg)	0.003	0.002	ND	ND	ND	ND	ND
2-butanone	Frequency of Detection	10/12	6/6	ND	4/5	ND	ND	ND
	Range (mg/kg)	0.001-0.026	0.002-0.026	ND	0.001-0.010	ND	ND	ND
	Mean[a] (mg/kg)	0.007	0.008	ND	0.006	ND	ND	ND
2-methyl naphthalene	Frequency of Detection	4/8	4/5	ND	ND	ND	ND	ND
	Range (mg/kg)	0.100-0.760	0.100-0.760	ND	ND	ND	ND	ND
	Mean[a] (mg/kg)	0.266	0.303	ND	ND	ND	ND	ND
4-methyl-2-pentanone	Frequency of Detection	1/12	1/6	ND	ND	ND	ND	ND
	Range (mg/kg)	0.003-0.003	0.003-0.003	ND	ND	ND	ND	ND
	Mean[a] (mg/kg)	0.005	0.005	ND	ND	ND	ND	ND
Acenaphthene	Frequency of Detection	3/11	1/6	ND	2/5	ND	ND	ND
	Range (mg/kg)	0.110-4.800	4.800-4.800	ND	0.110-1.600	ND	ND	ND
	Mean[a] (mg/kg)	0.406	1.106	ND	0.499	ND	ND	ND

See footnotes at end of table.

TABLE 4-73B (Continued)

Chemical	Parameters	Sampling Depth 0 - 6 in.						
		Entire Site	NE Quadrant	NW Quadrant	SW Quadrant	Remainder of the Site	Waste Storage Area	Silo Area
Acetone	Frequency of Detection	9/12	4/6	ND	4/5	1/1	ND	ND
	Range (mg/kg)	0.006-0.027	0.006-0.018	ND	0.006-0.027	0.015-0.015	ND	ND
	Mean[a] (mg/kg)	0.012	0.011	ND	0.012	[b]	ND	ND
Anthracene	Frequency of Detection	4/11	2/6	ND	2/5	ND	ND	ND
	Range (mg/kg)	0.170-6.200	0.330-6.200	ND	0.170-2.800	ND	ND	ND
	Mean[a] (mg/kg)	0.424	1.278	ND	0.751	ND	ND	ND
Aroclor-1254	Frequency of Detection	29/29	3/3	11/11	4/4	4/4	6/6	1/1
	Range (mg/kg)	0.100-1.500	0.460-1.200	0.010-1.500	0.120-1.000	0.014-0.120	0.013-1.400	0.030-0.030
	Mean[a] (mg/kg)	0.368	0.783	0.442	0.420	0.047	0.260	[b]
Aroclor-1260	Frequency of Detection	5/5	2/2	ND	2/2	ND	1/1	ND
	Range (mg/kg)	0.037-2.800	0.230-2.800	ND	0.340-1.000	ND	0.037-0.037	ND
	Mean[a] (mg/kg)	0.881	[b]	ND	[b]	ND	[b]	ND
Benzo(a) anthracene	Frequency of Detection	6/8	3/4	ND	3/4	ND	ND	ND
	Range (mg/kg)	0.051-19.000	0.051-19.000	ND	0.061-5.400	ND	ND	ND
	Mean[a] (mg/kg)	0.593	5.309	ND	1.579	ND	ND	ND
Benzo(a) pyrene	Frequency of Detection	6/6	3/3	ND	3/3	ND	ND	ND
	Range (mg/kg)	0.046-24.000	0.081-24.000	ND	0.046-5.100	ND	ND	ND
	Mean[a] (mg/kg)	0.889	8.794	ND	1.872	ND	ND	ND

See footnotes at end of table.

TABLE 4-73B (Continued)

Chemical	Parameters	Sampling Depth 0 - 6 in.						
		Entire Site	NE Quadrant	NW Quadrant	SW Quadrant	Remainder of the Site	Waste Storage Area	Silo Area
Benzo(b) fluoranthene	Frequency of Detection	6/8	4/4	ND	2/4	ND	ND	ND
	Range (mg/kg)	0.095-39.000	0.095-39.000	ND	0.110-4.700	ND	ND	ND
	Mean[a] (mg/kg)	0.596	10.373	ND	1.300	ND	ND	ND
Benzo(g,h,i) perylene	Frequency of Detection	4/8	2/4	ND	2/4	ND	ND	ND
	Range (mg/kg)	0.400-12.000	1.900-12.000	ND	0.400-3.700	ND	ND	ND
	Mean[a] (mg/kg)	0.694	3.571	ND	1.129	ND	ND	ND
Benzo(k) fluoranthene	Frequency of Detection	6/7	3/3	ND	3/4	ND	ND	ND
	Range (mg/kg)	0.081-5.000	0.081-2.600	ND	0.090-5.000	ND	ND	ND
	Mean[a] (mg/kg)	1.259	0.934	ND	1.504	ND	ND	ND
Benzoic acid	Frequency of Detection	1/11	1/6	ND	ND	ND	ND	ND
	Range (mg/kg)	0.250-0.250	0.250-0.250	ND	ND	ND	ND	ND
	Mean[a] (mg/kg)	2.205	2.792	ND	ND	ND	ND	ND
Carbon disulfide	Frequency of Detection	1/12	1/6	ND	ND	ND	ND	ND
	Range (mg/kg)	0.004-0.004	0.004-0.004	ND	ND	ND	ND	ND
	Mean[a] (mg/kg)	0.003	0.003	ND	ND	ND	ND	ND
Chlorobenzene	Frequency of Detection	1/12	1/6	ND	ND	ND	ND	ND
	Range (mg/kg)	0.001-0.001	0.001-0.001	ND	ND	ND	ND	ND
	Mean[a] (mg/kg)	0.003	0.003	ND	ND	ND	ND	ND

See footnotes at end of table.

TABLE 4-73B (Continued)

Chemical	Parameters	Sampling Depth 0 - 6 in.						
		Entire Site	NE Quadrant	NW Quadrant	SW Quadrant	Remainder of the Site	Waste Storage Area	Silo Area
Chloroform	Frequency of Detection	2/12	2/6	ND	ND	ND	ND	ND
	Range (mg/kg)	0.009-0.014	0.009-0.014	ND	ND	ND	ND	ND
	Mean[a] (mg/kg)	0.004	0.006	ND	ND	ND	ND	ND
Chrysene	Frequency of Detection	6/8	3/4	ND	3/4	ND	ND	ND
	Range (mg/kg)	0.083-18.000	0.083-18.000	ND	0.100-7.200	ND	ND	ND
	Mean[a] (mg/kg)	0.708	5.042	ND	2.089	ND	ND	ND
Dibenzo(a,h) anthrancene	Frequency of Detection	3/8	2/4	ND	1/4	ND	ND	ND
	Range (mg/kg)	0.610-6.900	0.610-6.900	ND	1.500-1.500	ND	ND	ND
	Mean[a] (mg/kg)	0.459	1.974	ND	0.528	ND	ND	ND
Dibenzofuran	Frequency of Detection	4/11	2/6	ND	2/5	ND	ND	ND
	Range (mg/kg)	0.055-2.000	0.081-2.000	ND	0.055-0.640	ND	ND	ND
	Mean[a] (mg/kg)	0.456	0.590	ND	0.296	ND	ND	ND
Fluoranthene	Frequency of Detection	9/11	5/6	ND	4/5	ND	ND	ND
	Range (mg/kg)	0.043-33.000	0.081-33.000	ND	0.043-10.000	ND	ND	ND
	Mean[a] (mg/kg)	4.533	6.288	ND	2.427	ND	ND	ND
Fluorene	Frequency of Detection	3/11	1/6	ND	2/5	ND	ND	ND
	Range (mg/kg)	0.130-3.300	3.300-3.300	ND	0.130-1.700	ND	ND	ND
	Mean[a] (mg/kg)	0.705	0.856	ND	0.523	ND	ND	ND

See footnotes at end of table.

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TABLE 4-73B (Continued)

Chemical	Parameters	Sampling Depth 0 - 6 in.						
		Entire Site	NE Quadrant	NW Quadrant	SW Quadrant	Remainder of the Site	Waste Storage Area	Silo Area
Indeno(1,2,3-cd) pyrene	Frequency of Detection	4/8	2/4	ND	2/4	ND	ND	ND
	Range (mg/kg)	0.280-13.000	1.700-13.000	ND	0.280-2.900	ND	ND	ND
	Mean[a] (mg/kg)	0.641	3.771	ND	0.899	ND	ND	ND
Methylene chloride	Frequency of Detection	12/12	6/6	ND	5/5	1/1	ND	ND
	Range (mg/kg)	0.006-0.028	0.006-0.028	ND	0.007-0.021	0.025-0.025	ND	ND
	Mean[a] (mg/kg)	0.018	0.020	ND	0.015		ND	ND
N-Nitroso-diphenylamine	Frequency of Detection	3/11	2/6	ND	1/5	ND	ND	ND
	Range (mg/kg)	0.100-0.200	0.120-0.200	ND	0.100-0.100	ND	ND	ND
	Mean[a] (mg/kg)	0.376	0.480	ND	0.252	ND	ND	ND
Naphthalene	Frequency of Detection	3/11	3/6	ND	ND	ND	ND	ND
	Range (mg/kg)	0.089-1.300	0.089-1.300	ND	ND	ND	ND	ND
	Mean[a] (mg/kg)	0.397	0.473	ND	ND	ND	ND	ND
Phenanthrene	Frequency of Detection	9/10	6/6	ND	3/4	ND	ND	ND
	Range (mg/kg)	0.079-22.000	0.079-22.000	ND	0.120-8.800	ND	ND	ND
	Mean[a] (mg/kg)	3.409	4.005	ND	2.516	ND	ND	ND
Pyrene	Frequency of Detection	7/11	4/6	ND	3/5	ND	ND	ND
	Range (mg/kg)	0.130-22.000	0.130-22.000	ND	0.180-10.000	ND	ND	ND
	Mean[a] (mg/kg)	3.597	4.570	ND	2.429	ND	ND	ND

See footnotes at end of table.

TABLE 4-73B (Continued)

Chemical	Parameters	Sampling Depth 0 - 6 in.						
		Entire Site	NE Quadrant	NW Quadrant	SW Quadrant	Remainder of the Site	Waste Storage Area	Silo Area
Tetrachloro-ethene	Frequency of Detection	4/12	2/6	ND	2/5	ND	ND	ND
	Range (mg/kg)	0.001-0.010	0.005-0.010	ND	0.001-0.002	ND	ND	ND
	Mean[a] (mg/kg)	0.003	0.004	ND	0.002	ND	ND	ND
Toluene	Frequency of Detection	7/12	5/6	ND	2/5	ND	ND	ND
	Range (mg/kg)	0.001-0.004	0.001-0.004	ND	0.001-0.002	ND	ND	ND
	Mean[a] (mg/kg)	0.002	0.003	ND	0.002	ND	ND	ND
Tributyl phosphate	Frequency of Detection	1/2	ND	ND	1/1	ND	ND	ND
	Range (mg/kg)	1.200-1.200	ND	ND	1.200-1.200	ND	ND	ND
	Mean[a] (mg/kg)	[b]	ND	ND	[b]	ND	ND	ND
Trichloroethene	Frequency of Detection	5/12	3/6	ND	2/5	ND	ND	ND
	Range (mg/kg)	0.001-0.018	0.001-0.018	ND	0.003-0.005	ND	ND	ND
	Mean[a] (mg/kg)	0.004	0.005	ND	0.003	ND	ND	ND
beta-BHC	Frequency of Detection	2/60	1/6	ND	1/5	ND	ND	ND
	Range (mg/kg)	0.100-0.220	0.100-0.100	ND	0.220-0.220	ND	ND	ND
	Mean[a] (mg/kg)	0.015	0.063	ND	0.058	ND	ND	ND
bis(2-ethylhexyl) phthalate	Frequency of Detection	4/11	1/6	ND	3/5	ND	ND	ND
	Range (mg/kg)	0.046-0.780	0.780-0.780	ND	0.046-0.180	ND	ND	ND
	Mean[a] (mg/kg)	0.435	0.619	ND	0.213	ND	ND	ND

See footnotes at end of table.

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TABLE 4-73B (Continued)

Chemical	Parameter	Sampling Depth 0 - 18 in.						
		Entire Site	NE Quadrant	NW Quadrant	SW Quadrant	Remainder of the Site	Waste Storage Area	Silo Area
1,1,1-tri-chloroethane	Frequency of Detection	12/52	12/38	ND	ND	ND	ND	ND
	Range (mg/kg)	0.001-1.700	0.001-1.700	ND	ND	ND	ND	ND
	Mean[a] (mg/kg)	0.004	0.004	ND	ND	ND	ND	ND
1,12,2-tetrachloroethane	Frequency of Detection	2/52	2/38	ND	ND	ND	ND	ND
	Range (mg/kg)	0.003-0.190	0.003-0.190	ND	ND	ND	ND	ND
	Mean[a] (mg/kg)	0.003	0.008	ND	ND	ND	ND	ND
1,1,2-trichloroethane	Frequency of Detection	1/52	1/38	ND	ND	ND	ND	ND
	Range (mg/kg)	0.014-0.014	0.014-0.014	ND	ND	ND	ND	ND
	Mean[a] (mg/kg)	0.003	0.003	ND	ND	ND	ND	ND
1,1-dichloroethane	Frequency of Detection	2/52	2/38	ND	ND	ND	ND	ND
	Range (mg/kg)	0.012-0.022	0.012-0.022	ND	ND	ND	ND	ND
	Mean[a] (mg/kg)	0.003	0.004	ND	ND	ND	ND	ND
1,1-dichloroethene	Frequency of Detection	2/52	1/38	ND	1/9	ND	ND	ND
	Range (mg/kg)	0.004-0.039	0.039-0.039	ND	0.004-0.004	ND	ND	ND
	Mean[a] (mg/kg)	0.004	-0.004	ND	0.003	ND	ND	ND
1,2-dichlorethylene	Frequency of Detection	5/52	4/38	ND	1/9	ND	ND	ND
	Range (mg/kg)	0.001-0.340	0.001-0.340	ND	0.002-0.002	ND	ND	ND
	Mean[a] (mg/kg)	0.003	0.003	ND	0.003	ND	ND	ND

See footnotes at end of table.

TABLE 4-73B (Continued)

Chemical	Parameter	Sampling Depth 0 - 18 in.						
		Entire Site	NE Quadrant	NW Quadrant	SW Quadrant	Remainder of the Site	Waste Storage Area	Silo Area
2-butanone	Frequency of Detection	31/52	21/38	2/2	8/9	ND	ND	ND
	Range (mg/kg)	0.001-0.049	0.001-0.026	0.003-0.008	0.001-0.049	ND	ND	ND
	Mean[a] (mg/kg)	0.006	0.006	[b]	0.010	ND	ND	ND
2-hexanone	Frequency of Detection	3/52	2/38	ND	ND	1/2	ND	ND
	Range (mg/kg)	0.002-0.004	0.002-0.004	ND	ND	0.003-0.003	ND	ND
	Mean[a] (mg/kg)	0.006	0.006	ND	ND	[b]	ND	ND
2-methyl-naphthalene	Frequency of Detection	11/44	11/34	ND	ND	ND	ND	ND
	Range (mg/kg)	0.056-0.760	0.056-0.760	ND	ND	ND	ND	ND
	Mean[a] (mg/kg)	0.200	0.201	ND	ND	ND	ND	ND
4-methyl-2-pentanone	Frequency of Detection	14/52	13/38	ND	ND	1/2	ND	ND
	Range (mg/kg)	0.001-0.014	0.001-0.014	ND	ND	0.002-0.002	ND	ND
	Mean[a] (mg/kg)	0.006	0.006	ND	ND	[b]	ND	ND
Acenaphthane	Frequency of Detection	6/52	3/39	ND	3/10	ND	ND	ND
	Range (mg/kg)	0.071-4.800	0.071-4.800	ND	0.110-1.600	ND	ND	ND
	Mean[a] (mg/kg)	0.238	0.239	ND	0.359	ND	ND	ND
Acetone	Frequency of Detection	45/52	35/38	1/2	7/9	2/2	ND	ND
	Range (mg/kg)	0.003-0.095	0.003-0.095	0.008-0.008	0.005-0.027	0.011-0.015	ND	ND
	Mean[a] (mg/kg)	0.014	0.016	[b]	0.010	[b]	ND	ND
Anthracene	Frequency of Detection	9/52	5/39	ND	4/10	ND	ND	ND
	Range (mg/kg)	0.060-6.200	0.073-6.200	ND	0.060-2.800	ND	ND	ND
	Mean[a] (mg/kg)	0.238	0.235	ND	0.267	ND	ND	ND

See footnotes at end of table.

TABLE 4-73B (Continued)

Chemical	Parameter	Sampling Depth 0 - 18 in.						
		Entire Site	NE Quadrant	NW Quadrant	SW Quadrant	Remainder of the Site	Waste Storage Area	Silo Area
Aroclor-1254	Frequency of Detection	46/46	19/19	11/11	5/5	4/4	6/6	1/1
	Range (mg/kg)	0.010-3.000	0.027-3.000	0.010-1.500	0.120-1.000	0.014-0.120	0.013-1.400	0.030-0.030
	Mean[a] (mg/kg)	0.529	0.583	0.442	0.370	0.032	0.050	[b]
Aroclor-1260	Frequency of Detection	11/11	7/7	ND	3/3	ND	1/1	ND
	Range (mg/kg)	0.037-2.800	0.120-2.800	ND	0.270-1.000	ND	0.037-0.037	ND
	Mean[a] (mg/kg)	0.674	0.824	ND	0.537	ND	[b]	ND
Benzene	Frequency of Detection	2/52	1/38	ND	1/9	ND	ND	ND
	Range (mg/kg)	0.002-0.005	0.002-0.002	ND	0.005-0.005	ND	ND	ND
	Mean[a] (mg/kg)	0.003	0.003	ND	0.003	ND	ND	ND
Benzo(a) anthracene	Frequency of Detection	16/45	10/34	ND	6/8	ND	ND	ND
	Range (mg/kg)	0.048-19.000	0.048-19.000	ND	0.061-5.400	ND	ND	ND
	Mean[a] (mg/kg)	0.246	0.231	ND	0.346	ND	ND	ND
Benzo(a) pyrene	Frequency of Detection	12/12	6/6	ND	6/6	ND	ND	ND
	Range (mg/kg)	0.046-24.000	0.079-24.000	ND	0.046-5.100	ND	ND	ND
	Mean[a] (mg/kg)	3.099	0.928	ND	0.336	ND	ND	ND
Benzo(b) fluoranthene	Frequency of Detection	13/45	9/34	ND	4/8	ND	ND	ND
	Range (mg/kg)	0.045-39.000	0.045-39.000	ND	0.110-4.700	ND	ND	ND
	Mean[a] (mg/kg)	0.260	0.256	ND	0.304	ND	ND	ND
Benzo(g,h,i) perylene	Frequency of Detection	9/45	4/34	ND	5/8	ND	ND	ND
	Range (mg/kg)	0.067-12.000	0.360-12.000	ND	0.067-3.700	ND	ND	ND
	Mean[a] (mg/kg)	0.256	0.251	ND	0.309	ND	ND	ND

See footnotes at end of table.

TABLE 4-73B (Continued)

Chemical	Parameter	Sampling Depth 0 - 18 in.						
		Entire Site	NE Quadrant	NW Quadrant	SW Quadrant	Remainder of the Site	Waste Storage Area	Silo Area
Benzo(k) fluoranthene	Frequency of Detection	11/44	5/33	ND	6/8	ND	ND	ND
	Range (mg/kg)	0.081-5.000	0.081-3.100	ND	0.090-5.000	ND	ND	ND
	Mean[a] (mg/kg)	0.245	0.224	ND	0.386	ND	ND	ND
Benzoic acid	Frequency of Detection	3/52	2/39	ND	1/10	ND	ND	ND
	Range (mg/kg)	0.088-0.250	0.170-0.250	ND	0.088-0.088	ND	ND	ND
	Mean[a] (mg/kg)	1.321	1.093	ND	1.129	ND	ND	ND
Carbon disulfide	Frequency of Detection	9/52	9/38	ND	ND	ND	ND	ND
	Range (mg/kg)	0.002-0.014	0.002-0.014	ND	ND	ND	ND	ND
	Mean[a] (mg/kg)	0.003	0.003	ND	ND	ND	ND	ND
Chlorobenzene	Frequency of Detection	3/52	2/38	ND	1/9	ND	ND	ND
	Range (mg/kg)	0.001-0.005	0.001-0.003	ND	0.005-0.005	ND	ND	ND
	Mean[a] (mg/kg)	0.003	0.003	ND	0.003	ND	ND	ND
Chloroform	Frequency of Detection	8/52	7/38	1/2	ND	ND	ND	ND
	Range (mg/kg)	0.001-0.046	0.001-0.046	0.004-0.004	ND	ND	ND	ND
	Mean[a] (mg/kg)	0.003	0.004	[b]	ND	ND	ND	ND
Chrysene	Frequency of Detection	14/45	8/34	ND	6/8	ND	ND	ND
	Range (mg/kg)	0.070-18.000	0.070-18.000	ND	0.100-7.200	ND	ND	ND
	Mean[a] (mg/kg)	0.272	0.250	ND	0.441	ND	ND	ND
Di-n-butyl-phthalate	Frequency of Detection	2/52	1/39	ND	1/10	ND	ND	ND
	Range (mg/kg)	0.046-0.049	0.049-0.049	ND	0.046-0.046	ND	ND	ND
	Mean[a] (mg/kg)	0.280	0.234	ND	0.256	ND	ND	ND

See footnotes at end of table.

TABLE 4-73B (Continued)

Chemical	Parameter	Sampling Depth 0 - 18 in.						
		Entire Site	NE Quadrant	NW Quadrant	SW Quadrant	Remainder of the Site	Waste Storage Area	Silo Area
Dibenzo(a,h) anthracene	Frequency of Detection	5/45	3/34	ND	2/8	ND	ND	ND
	Range (mg/kg)	0.140-6.900	0.610-6.900	ND	0.140-1.500	ND	ND	ND
	Mean[a] (mg/kg)	0.229	1.974	ND	0.355	ND	ND	ND
Dibenzofuran	Frequency of Detection	10/52	7/39	ND	3/10	ND	ND	ND
	Range (mg/kg)	0.050-2.000	0.050-2.000	ND	0.055-0.640	ND	ND	ND
	Mean[a] (mg/kg)	0.207	0.209	ND	0.253	ND	ND	ND
Ethylbenzene	Frequency of Detection	2/52	2/38	ND	ND	ND	ND	ND
	Range (mg/kg)	0.002-0.003	0.002-0.003	ND	ND	ND	ND	ND
	Mean[a] (mg/kg)	0.003	0.003	ND	ND	ND	ND	ND
Fluoranthene	Frequency of Detection	21/52	14/39	ND	7/10	ND	ND	ND
	Range (mg/kg)	0.043-33.000	0.051-33.000	ND	0.043-10.000	ND	ND	ND
	Mean[a] (mg/kg)	0.286	0.252	ND	1.555	ND	ND	ND
Fluorene	Frequency of Detection	6/52	2/39	ND	4/10	ND	ND	ND
	Range (mg/kg)	0.044-3.300	0.380-3.300	ND	0.044-1.700	ND	ND	ND
	Mean[a] (mg/kg)	0.235	0.241	ND	0.359	ND	ND	ND
Indeno(1,2,3-cd) pyrene	Frequency of Detection	9/45	4/34	ND	5/8	ND	ND	ND
	Range (mg/kg)	0.049-13.000	0.330-13.000	ND	0.049-2.900	ND	ND	ND
	Mean[a] (mg/kg)	0.247	0.250	ND	0.541	ND	ND	ND
Methylene chloride	Frequency of Detection	52/52	38/38	2/2	9/9	2/2	ND	1/1
	Range (mg/kg)	0.003-0.053	0.004-0.053	0.014-0.029	0.005-0.021	0.025-0.038	ND	0.003-0.003
	Mean[a] (mg/kg)	0.018	0.018	[b]	0.014	[b]	ND	[b]

See footnotes at end of table.

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TABLE 4-73B (Continued)

Chemical	Parameter	Sampling Depth 0 - 18 in.						
		Entire Site	NE Quadrant	NW Quadrant	SW Quadrant	Remainder of the Site	Waste Storage Area	Silo Area
N-nitroso-diphenylamine	Frequency of Detection	6/52	4/39	ND	2/10	ND	ND	ND
	Range (mg/kg)	0.043-0.200	0.043-0.200	ND	0.100-0.130	ND	ND	ND
	Mean[a] (mg/kg)	0.252	0.266	ND	0.216	ND	ND	ND
Naphthalene	Frequency of Detection	9/52	9/39	ND	ND	ND	ND	ND
	Range (mg/kg)	0.066-1.300	0.066-1.300	ND	ND	ND	ND	ND
	Mean[a] (mg/kg)	0.221	0.217	ND	ND	ND	ND	ND
Phenanthrene	Frequency of Detection	24/47	18/36	ND	6/8	ND	ND	ND
	Range (mg/kg)	0.037-22.000	0.037-22.000	ND	0.110-8.800	ND	ND	ND
	Mean[a] (mg/kg)	0.507	0.421	ND	0.476	ND	ND	ND
Phenol	Frequency of Detection	2/52	1/39	ND	1/10	ND	ND	ND
	Range (mg/kg)	0.069-0.200	0.200-0.200	ND	0.069-0.069	ND	ND	ND
	Mean[a] (mg/kg)	0.270	0.233	ND	0.256	ND	ND	ND
Pyrene	Frequency of Detection	19/52	13/39	ND	6/10	ND	ND	ND
	Range (mg/kg)	0.059-22.000	0.059-22.000	ND	0.180-10.000	ND	ND	ND
	Mean[a] (mg/kg)	0.507	0.259	ND	0.571	ND	ND	ND
Styrene	Frequency of Detection	1/52	1/38	ND	ND	ND	ND	ND
	Range (mg/kg)	0.005-0.005	0.005-0.005	ND	ND	ND	ND	ND
	Mean[a] (mg/kg)	0.003	0.003	ND	ND	ND	ND	ND
Tetrachloroethene	Frequency of Detection	12/52	10/38	ND	2/9	ND	ND	ND
	Range (mg/kg)	0.001-8.300	0.002-8.300	ND	0.001-0.002	ND	ND	ND
	Mean[a] (mg/kg)	0.004	0.005	ND	0.003	ND	ND	ND

See footnotes at end of table.

TABLE 4-73B (Continued)

Chemical	Parameter	Sampling Depth 0 - 18 in.						
		Entire Site	NE Quadrant	NW Quadrant	SW Quadrant	Remainder of the Site	Waste Storage Area	Silo Area
Toluene	Frequency of Detection	28/52	21/38	1/2	5/9	ND	ND	1/1
	Range (mg/kg)	0.001-0.011	0.001-0.011	0.007-0.007	0.001-0.005	ND	ND	0.002-0.002
	Mean[a] (mg/kg)	0.003	0.003	[b]	0.003	ND	ND	[b]
Total xylenes	Frequency of Detection	2/52	2/38	ND	ND	ND	ND	ND
	Range (mg/kg)	0.005-0.006	0.005-0.006	ND	ND	ND	ND	ND
	Mean[a] (mg/kg)	0.003	0.003	ND	ND	ND	ND	ND
Tributyl phosphate	Frequency of Detection	2/4	ND	ND	2/2	ND	ND	ND
	Range (mg/kg)	0.170-1.200	ND	ND	0.170-1.200	ND	ND	ND
	Mean[a] (mg/kg)	0.611	ND	ND	[b]	ND	ND	ND
Trichloroethene	Frequency of Detection	15/52	10/38	1/2	4/9	ND	ND	ND
	Range (mg/kg)	0.001-5.400	0.001-5.400	0.003-0.003	0.003-0.005	ND	ND	ND
	Mean[a] (mg/kg)	0.004	0.004	[b]	0.003	ND	ND	ND
beta-BHC	Frequency of Detection	4/101	2/39	ND	2/10	ND	ND	ND
	Range (mg/kg)	0.016-0.220	0.016-0.100	ND	0.046-0.220	ND	ND	ND
	Mean[a] (mg/kg)	0.014	0.011	ND	0.038	ND	ND	ND
bis(2-ethylhexyl) phthalate	Frequency of Detection	17/52	12/39	ND	5/10	ND	ND	ND
	Range (mg/kg)	0.041-8.400	0.041-8.400	ND	0.046-0.180	ND	ND	ND
	Mean[a] (mg/kg)	0.250	0.293	ND	0.145	ND	ND	ND
						ND	ND	ND

[a]If number of detects <7 or frequency of detection <50%, a geometric mean is given, otherwise, an arithmetic mean is given.
[b]Not applicable if sample size ≤2.
[c]ND, not detected.

See footnotes at end of table.

4.1.6 Subsurface Soils

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4.1.6 Subsurface Soils

Sampling of subsurface media was conducted as part of the CIS (Weston 1987b), the sampling and analysis by DOE (1988) and the RI/FS investigation. Samples were analyzed for both radiological and chemical constituents in all three investigations.

The CIS (Weston 1987b) showed above background concentrations of isotopes of uranium, thorium, technetium, cesium and radium in the waste storage area. Chemical analysis of the pits revealed aluminum, calcium, iron and magnesium as the principle inorganic constituents, while concentrations of both semivolatile and volatile organic materials varied widely from pit to pit. Since there was no historical basis for the presence of activation or fission products in the fly ash piles, samples taken from those locations were analyzed for fewer radionuclides. Results from the analysis showed that uranium isotopes are the principle radionuclides present in both the active and inactive fly ash piles, and the southfield. Uranium-234 and U-238 were the only radionuclides present with mean concentrations exceeding 10 pCi/g in the solid waste landfill. Aluminum, calcium, iron and magnesium were the dominant inorganics in the fly ash piles, the solid waste landfill and the lime sludge ponds. PCBs were detected in the fly ash piles, the solid waste landfill and the north lime sludge pond. The south lime sludge pond contained no measurable quantities of either semivolatile or volatile organics.

Uranium isotopes were the primary constituents detected in DOE (1988) subsurface samples collected inside and outside the production area of the FEMP. Samples collected for chemical analysis contained detectable acetone, methylene chloride and chloroform. Barium was the most often detected RCRA metal.

RI/FS subsurface samples from the Waste Pits 1 and 3 had consistent detections of isotopes of uranium, thorium and radium. The subsurface soil samples from the K-65 berm sampling primarily contained isotopes of thorium and uranium. Lead-210 and Ra-226 were also detected. The K-65 slant borings showed U-238 as the main radionuclide detected. Chemical results from the waste pits showed detectable chloroform and tetrachloroethene, and very high levels of total organic carbon; while chemicals detected in the K-65 berms included methylene chloride, 2-butanone and acetone. Isotopes of uranium were also the most commonly detected radionuclides in the solid waste landfill, and the active and inactive fly ash piles. Methylene chloride was also detected in all three areas. Samples collected in the production area revealed above background levels of uranium and thorium, as well as Tc-99, Ra-226, Ra-228 and Cs-127. Plutonium was also detected in Plant 6. Chemical analysis showed a wide variety of compounds detected in production area samples, including N-nitroso-di-n-propylamine, bis(2-ethylhexyl) phthalate, benzoic acid, phenanthrene and fluoranthene.

4.1.6.1 "Characterization Investigation Study," Volume 2, Weston (1987b)

A summary of the radionuclide and chemical concentrations for the waste pits is presented in Tables

4-74 and 4-75 A, B. In Waste Pit 1, isotopes of uranium and Th-230 are the predominant radionuclides, with shows peak concentrations of U-234, U-235 and U-238 of 1,180 pCi/g, 151 pCi/g and 7,090 pCi/g, respectively (Table 4-74). Thorium-230 was detected in all samples from Waste Pit 1. The remaining radionuclides were low in activity compared to Th-230, except for Ra-226, which was detected as high as 120 pCi/g across the pit.

All of the samples from the boreholes in the waste pit area, solid waste landfill and lime sludge ponds were within the established RCRA parameter limits for corrosivity, measured by pH; ignitability; and reactivity. The EP-TOX metals from all of the sampled areas were below the maximum allowable concentration.

In Waste Pit 1, aluminum, calcium, iron and magnesium were the inorganics present in the highest mean concentrations throughout the pit (Table 4-75A), while PCBs were the highest organics detected (Table 4-75B). The semivolatiles chrysene and phenanthrene were detected in concentrations up to 510 µg/kg and 2,300 µg/kg, respectively, and trace amounts of chloroform and 4,4-DDT were also detected (Table 4-75B).

The dominant radionuclide detected in Waste Pit 2 was uranium with maximum concentrations of 18,200 pCi/g for U-234, 8,780 pCi/g for U-235 and 17,900 pCi/g for U-238 (Table 4-74). Thorium-230 was detected in Waste Pit 2, but the remaining radionuclides analyzed in the samples were below 600 pCi/g except for Tc-99 and Ra-226 (Table 4-74).

Aluminum, calcium, iron and magnesium were present in Waste Pit 2 in mean concentrations exceeding 15,000 mg/kg (Table 4-75A). PCBs were detected in peak concentrations of 1800 µg/kg; 4,4-DDT was found in samples in concentrations up to 1400 µg/kg; and vinyl chloride, a volatile, was detected in amounts as high as 670 µg/kg. Numerous semivolatile compounds, including fluoranthenes and pyrenes, were also detected (Table 4-75B).

The radionuclides with the highest concentrations in Waste Pit 3 were Th-230, Tc-99, Ra-226 and U-238, with maximum concentrations of 30,520 pCi/g, 2,190 pCi/g, 1,668 pCi/g and 1,380 pCi/g, respectively (Table 4-74). The remaining radionuclides analyzed were below 500 pCi/g in activity.

As in the other pits, aluminum, calcium, iron and magnesium were the inorganics present in the highest quantities in Waste Pit 3. Arsenic was detected in peak concentrations of 3049 mg/kg (Table 4-75A). Vanadium and lead were also found in concentrations up to 9696 and 613 mg/kg, respectively. Aroclor-1254, bis(2-ethylhexyl)phthalate, and pentachlorophenol (2) were the only organics detected in quantities exceeding 500 µg/kg in Waste Pit 3 (Table 4-75B).

Thorium-230, U-234, and U-238 were the predominant radionuclides present in Waste Pit 4, with peak

TABLE 4-74
RADIONUCLIDES DETECTED DURING CIS SUBSURFACE SOIL SAMPLING

Radionuclide	Parameter	Waste Pit 1	Waste Pit 2	Waste Pit 3	Waste Pit 4	Waste Pit 5	Waste Pit 6	Burn Pit	Clearwell
Am-241	Frequency of Detection	ND[c]	ND	3/3	ND	ND	ND	ND	ND
	Range (pCi/g)	ND	ND	32.000-49.100	ND	ND	ND	ND	ND
	Mean[a] (pCi/g)	ND	ND	39.700	ND	ND	ND	ND	ND
Cs-137	Frequency of Detection	1/60	2/42	3/117	ND	15/73	9/28	ND	4/4
	Range (pCi/g)	1.100-1.100	0.700-3.600	5.700-19.000	ND	2.000-76.000	3.100-31.000	ND	18.000-450.00
	Mean[a] (pCi/g)	1.709	1.876	1.336	ND	1.937	5.638	ND	189.50
Np-237	Frequency of Detection	ND	ND	4/9	1/4	6/6	4/4	2/6	3/4
	Range (pCi/g)	ND	ND	0.300-2.100	0.400-0.400	0.300-23.000	0.900-4.500	0.700-0.700	0.800-2.700
	Mean[a] (pCi/g)	ND	ND	0.209	0.188	5.113	2.475	0.182	1.275
Pu-238	Frequency of Detection	ND	2/5	5/9	4/4	5/6	4/4	4/6	1/4
	Range (pCi/g)	ND	0.100-0.100	0.100-1.000	0.100-0.500	0.400-4.400	0.400-1.400	0.100-0.500	0.100-0.100
	Mean[a] (pCi/g)	ND	0.070	0.110	0.275	1.992	0.696	0.104	0.063
Pu-239/240	Frequency of Detection	ND	2/5	6/9	4/4	5/6	4/4	4/6	ND
	Range (pCi/g)	ND	0.050-0.600	0.300-14.000	0.100-0.400	0.400-13.000	4.000-15.000	0.100-0.400	ND
	Mean[a] (pCi/g)	ND	0.082	0.433	0.200	5.025	8.700	0.100	ND
Ra-226	Frequency of Detection	61/63	34/42	103/113	58/68	68/68	1/24	59/67	3/3
	Range (pCi/g)	1.100-120.00	1.000-613.00	0.600-1668.4	0.700-76.200	2.000-382.68	8.000-8.000	0.400-24.800	20.510-438.22
	Mean[a] (pCi/g)	41.941	128.61	194.14	19.421	103.08	6.515	2.121	159.77
Ru-106	Frequency of Detection	1/63	1/42	ND	1/67	ND	ND	ND	ND
	Range (pCi/g)	9.800-9.800	35.000-35.000	ND	19.400-19.400	ND	ND	ND	ND
	Mean[a] (pCi/g)	12.263	17.539	ND	21.100	ND	ND	ND	ND
Sr-90	Frequency of Detection	ND	ND	2/9	ND	5/6	3/4	ND	4/4
	Range (pCi/g)	ND	ND	2.400-26.000	ND	0.800-23.000	1.300-4.000	ND	1.300-26.000
	Mean[a] (pCi/g)	ND	ND	0.775	ND	3.834	1.838	ND	4.355

TABLE 4-74
(Continued)

Radionuclide	Parameter	Waste Pit 1	Waste Pit 2	Waste Pit 3	Waste Pit 4	Waste Pit 5	Waste Pit 6	Burn Pit	Clearwell
Tc-99	Frequency of Detection	1/5	3/5	8/9	4/4	6/6	4/4	4/6	3/4
	Range (pCi/g)	15.000-15.000	11.000-722.00	47.000-2190.0	6.800-225.00	576.00-2990.0	106.00-164.00	18.000-83.000	94.000-322.00
	Mean[a] (pCi/g)	1.303	8.892	455.39	40.900	1095.4	132.50	7.046	133.30
Th-228	Frequency of Detection	5/5	5/5	9/9	4/4	6/6	4/4	6/6	3/4
	Range (pCi/g)	6.100-52.000	11.000-164.00	1.000-82.000	18.000-395.00	41.000-191.00	0.200-2.000	1.500-18.000	20.000-56.000
	Mean[a] (pCi/g)	15.102	42.363	26.656	44.018	76.818	0.950	7.467	28.809
Th-230	Frequency of Detection	5/5	5/5	9/9	4/4	6/6	4/4	6/6	4/4
	Range (pCi/g)	326.00-3600.0	41.000-3980.0	15.000-30520	225.00-566.00	3080.0-20200	14.000-41.000	5.700-224.00	105.00-5600.0
	Mean[a] (pCi/g)	1016.2	552.64	10452	428.25	9878.3	26.500	30.696	618.29
Th-232	Frequency of Detection	54/63	33/42	91/117	59/68	72/73	4/28	57/67	3/4
	Range (pCi/g)	1.000-57.000	0.800-563.00	0.300-121.00	0.600-467.00	6.800-580.00	0.200-1.200	0.700-69.400	15.000-39.000
	Mean[a] (pCi/g)	18.746	41.553	17.043	32.757	36.300	6.310	4.132	18.850
U-234	Frequency of Detection	5/5	5/5	9/9	4/4	6/6	4/4	6/6	4/4
	Range (pCi/g)	244.0-1180.0	39.000-18200	27.000-475.00	149.00-2320.0	310.00-1250.0	2000.0-5330.0	9.900-415.00	242.00-376.00
	Mean[a] (pCi/g)	486.26	487.07	250.89	440.65	566.69	3417.5	135.15	284.85
U-235	Frequency of Detection	5/5	5/5	12/12	4/4	68/73	4/4	6/6	4/4
	Range (pCi/g)	16.000-151.00	1.000-8780.0	2.500-138.00	35.000-426.00	9.500-79.000	350.00-1750.0	0.500-27.000	24.000-49.000
	Mean[a] (pCi/g)	41.171	59.548	29.383	94.620	28.943	1042.5	8.367	35.000
U-238	Frequency of Detection	63/63	42/42	112/117	68/68	55/73	28/28	59/67	4/4
	Range (pCi/g)	9.100-7090.0	9.300-17900	3.300-1380.0	3.300-16100	18.200-1230.0	290.00-18700	2.700-454.00	548.00-670.00
	Mean[a] (pCi/g)	754.19	1921.5	190.82	2344.4	194.56	6984.6	105.81	621.50

See footnotes at end of table.

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TABLE 4-74
(Continued)

		Active Flyash Pile	Inactive Flyash Pile	Southfield Area	Solid Waste Landfill	North Lime Sludge Pond	South Lime Sludge Pond
Cs-137	Frequency of Detection	ND	ND	ND	ND	ND	1/39
	Range (pCi/g)	ND	ND	ND	ND	ND	0.400-0.400
	Mean[a] (pCi/g)	ND	ND	ND	ND	ND	0.282
Pb-210	Frequency of Detection	1/2	2/2	10/10	ND	ND	ND
	Range (pCi/g)	4.000-4.000	3.000-5.000	2.000-28.000	ND	ND	ND
	Mean[a] (pCi/g)	[b]	[b]	7.600	ND	ND	ND
Pu-238	Frequency of Detection	ND	ND	ND	1/6	ND	ND
	Range (pCi/g)	ND	ND	ND	0.100-0.100	ND	ND
	Mean[a] (pCi/g)	ND	ND	ND	0.058	ND	ND
Ra-226	Frequency of Detection	13/25	57/63	79/100	50/79	2/12	5/36
	Range (pCi/g)	0.300-4.300	0.800-7.900	0.500-46.000	0.400-4.600	0.700-0.900	0.300-2.000
	Mean[a] (pCi/g)	0.924	2.214	1.834	0.814	0.496	0.535
Ra-228	Frequency of Detection	ND	2/2	9/10	ND	ND	ND
	Range (pCi/g)	ND	1.700-2.000	0.600-10.000	ND	ND	ND
	Mean[a] (pCi/g)	ND	[b]	3.080	ND	ND	ND
Ru-106	Frequency of Detection	ND	ND	1/90	ND	ND	ND
	Range (pCi/g)	ND	ND	14.600-14.600	ND	ND	ND
	Mean[a] (pCi/g)	ND	ND	2.901	ND	ND	ND
Sr-90	Frequency of Detection	ND	ND	ND	ND	1/3	ND
	Range (pCi/g)	ND	ND	ND	ND	2.200-2.200	ND
	Mean[a] (pCi/g)	ND	ND	ND	ND	0.516	ND
Th-228	Frequency of Detection	2/2	2/2	9/10	5/6	3/3	3/3
	Range (pCi/g)	0.900-1.700	2.100-2.300	0.100-38.000	0.700-2.900	0.200-0.200	0.100-0.300
	Mean[a] (pCi/g)	[b]	[b]	7.475	0.995	0.200	0.200

See footnotes at end of table.

TABLE 4-74
(Continued)

		Active Flyash Pile	Inactive Flyash Pile	Southfield Area	Solid Waste Landfill	North Lime Sludge Pond	South Lime Sludge Pond
Th-230	Frequency of Detection	2/2	2/2	10/10	6/6	3/3	3/3
	Range (pCi/g)	0.700-5.300	2.700-11.000	0.500-19.000	1.700-7.800	0.500-20.000	0.900-7.000
	Mean[a] (pCi/g)	[b]	[b]	5.700	3.192	3.684	3.000
Th-232	Frequency of Detection	9/25	53/63	70/100	52/79	7/15	9/39
	Range (pCi/g)	0.100-1.100	0.600-3.600	0.500-101.00	0.500-79.700	0.200-0.900	0.100-1.000
	Mean[a] (pCi/g)	0.666	1.958	3.148	1.869	0.433	0.369
U-234	Frequency of Detection	2/2	2/2	10/10	6/6	3/3	3/3
	Range (pCi/g)	4.500-5.700	3.700-48.000	2.000-15.000	4.900-28.000	2.100-2.500	1.800-3.100
	Mean[a] (pCi/g)	[b]	[b]	8.220	10.917	2.367	2.300
U-235	Frequency of Detection	2/2	2/2	10/10	6/6	3/3	3/3
	Range (pCi/g)	0.120-2.000	0.200-2.200	0.090-0.800	0.400-1.400	0.100-0.200	0.100-0.300
	Mean[a] (pCi/g)	[b]	[b]	0.399	0.547	0.133	0.167
U-238	Frequency of Detection	9/25	29/63	42/100	43/79	9/15	17/39
	Range (pCi/g)	2.300-18.200	2.600-160.00	2.700-42.000	2.200-338.00	1.700-7.600	1.200-6.700
	Mean[a] (pCi/g)	4.250	9.465	9.493	11.254	3.600	3.729

[a]If number of detects <7 or frequency of detection <50%, a geometric mean is given, otherwise, an arithmetic mean is given.
[b]Not applicable if sample size ≤2.
[c]ND, not detected.

See footnotes at end of table.

TABLE 4-75A
INORGANIC CHEMICALS DETECTED DURING CIS SUBSURFACE SOIL SAMPLING

Chemical	Parameter	Waste Pit 1	Waste Pit 2	Waste Pit 3	Waste Pit 4	Waste Pit 5	Waste Pit 6	Burn Pit	Clearwell
Aluminum	Frequency of Detection	5/5	4/4	6/6	4/4	6/6	1/1	6/6	3/3
	Range (mg/kg)	1702.9-20223	7242.3-22422	10366-64100	3645.6-10326	6373.8-15400	4730.4-4730.4	2911.6-11936	12939-23771
	Mean[a] (mg/kg)	9660.1	16445	24061	7087.9	10542	[b]	6802.6	18512
Antimony	Frequency of Detection	ND[c]	ND	ND	ND	1/1	ND	ND	ND
	Range (mg/kg)	ND	ND	ND	ND	28.000-28.000	ND	ND	ND
	Mean(mg/kg)	ND	ND	ND	ND	[b]	ND	ND	ND
Arsenic	Frequency of Detection	2/2	4/4	6/6	1/1	6/6	1/1	3/3	3/3
	Range (mg/kg)	14.460-15.200	2.750-10.060	15.410-3049.1	4.630-4.630	139.00-2800.0	7.610-7.610	4.380-20.910	9.110-18.460
	Mean[a] (mg/kg)	[b]	5.133	1052.1	[b]	530.05	[b]	8.886	13.220
Barium	Frequency of Detection	5/5	4/4	6/6	4/4	6/6	1/1	5/5	3/3
	Range (mg/kg)	116.48-365.48	96.700-208.49	251.19-14355	444.03-6668.8	15800-36939	95.220-95.220	56.230-7079.2	733.35-6913.4
	Mean[a] (mg/kg)	232.01	137.73	2015.3	2408.6	21266	[b]	271.06	2297.2
Beryllium	Frequency of Detection	1/1	3/3	5/5	1/1	6/6	2/2	2/2	1/1
	Range (mg/kg)	2.200-2.200	1.870-8.920	5.470-24.010	13.300-13.300	2.850-18.000	2.000-5.730	1.450-16.380	9.100-9.100
	Mean[a] (mg/kg)	[b]	3.887	9.865	[b]	[b]	[b]	[b]	[b]
Cadmium	Frequency of Detection	3/3	4/4	6/6	3/3	2/2	2/2	3/3	2/2
	Range (mg/kg)	1.460-4.960	3.040-9.590	2.530-12.650	1.920-28.720	4.400-17.000	0.600-5.730	1.330-34.840	5.110-7.150
	Mean[a] (mg/kg)	3.090	5.918	5.998	10.890	[b]	[b]	[b]	[b]

See footnotes at end of table.

TABLE 4-75A (Continued)

Chemical	Parameter	Waste Pit 1	Waste Pit 2	Waste Pit 3	Waste Pit 4	Waste Pit 5	Waste Pit 6	Burn Pit	Clearwell
Calcium	Frequency of Detection	5/5	4/4	6/6	4/4	6/6	1/1	6/6	3/3
	Range (mg/kg)	4755.8-192498	34414-80154	53183-178241	14253-61253	116000-206144	22190-22190	10114-116322	129305-183078
	Mean[a] (mg/kg)	28077	53873	100949	44250	169330	[b]	25751	156323
Chromium	Frequency of Detection	4/4	4/4	6/6	4/4	6/6	4/4	6/6	3/3
	Range (mg/kg)	6.350-46.330	17.080-91.260	20.000-151.84	7.920-93.630	25.660-223.29	4.800-29.740	7.870-87.520	41.170-76.050
	Mean[a] (mg/kg)	22.338	35.270	58.164	33.725	119.83	18.885	14.691	51.729
Cobalt	Frequency of Detection	1/1	4/4	ND	1/1	3/3	1/1	2/2	1/1
	Range (mg/kg)	27.850-27.850	13.630-450.56	ND	84.060-84.060	16.000-43.990	26.090-26.090	22.220-104.11	18.340-18.340
	Mean[a] (mg/kg)	[b]	60.663	ND	[b]	32.647	[b]	[b]	[b]
Copper	Frequency of Detection	5/5	4/4	6/6	4/4	6/6	4/4	6/6	3/3
	Range (mg/kg)	20.090-160.79	38.380-329.06	79.500-2332.7	22.800-187.73	672.21-3370.0	13.000-222.02	12.250-166.54	194.61-1119.3
	Mean[a] (mg/kg)	50.512	118.45	1081.5	71.985	2255.5	112.26	28.273	642.30
Cyanide	Frequency of Detection	ND	ND	ND	ND	ND	ND	ND	1/1
	Range (mg/kg)	ND	ND	ND	ND	ND	ND	ND	9.180-9.180
	Mean[a] (mg/kg)	ND	ND	ND	ND	ND	ND	ND	[b]
Iron	Frequency of Detection	5/5	4/4	6/6	4/4	6/6	1/1	6/6	3/3
	Range (mg/kg)	1832.6-19688	13265-24038	10730-26919	3045.6-16128	10979-17900	2749.9-2749.9	3746.9-17445	19618-21067
	Mean[a] (mg/kg)	7961.5	20249	18021	8931.1	14790	[b]	9576.0	20163

See footnotes at end of table.

TABLE 4-75A (Continued)

Chemical	Parameter	Waste Pit 1	Waste Pit 2	Waste Pit 3	Waste Pit 4	Waste Pit 5	Waste Pit 6	Burn Pit	Clearwell
Lead	Frequency of Detection	5/5	4/4	6/6	4/4	6/6	4/4	6/6	3/3
	Range (mg/kg)	4.980-89.920	25.470-190.29	51.680-613.21	23.550-62.510	59.500-236.00	5.000-59.620	6.680-52.580	32.260-83.000
	Mean[a] (mg/kg)	20.813	83.605	231.69	42.758	157.52	29.905	16.451	46.941
Magnesium	Frequency of Detection	5/5	4/4	6/6	4/4	6/6	1/1	6/6	3/3
	Range (mg/kg)	7613.8-36957	8885.0-26677	25156-51570	11424-24251	25202-63200	32101-32101	3859.1-57079	16785-44629
	Mean[a] (mg/kg)	25333	19008	30699	18806	48182	[b]	12184	29452
Manganese	Frequency of Detection	5/5	4/4	6/6	4/4	6/6	1/1	6/6	3/3
	Range (mg/kg)	144.81-2914.7	528.84-916.57	517.71-10571	1752.0-3596.4	346.29-4740.0	34.960-34.960	119.19-1717.3	761.15-1660.4
	Mean[a] (mg/kg)	1362.0	721.35	1347.6	2649.8	1819.2	[b]	284.27	1193.8
Mercury	Frequency of Detection	2/2	3/3	4/4	3/3	6/6	3/3	3/3	3/3
	Range (mg/kg)	0.260-0.360	0.220-0.700	0.450-4.010	0.180-0.630	0.390-1.800	0.030-0.070	0.140-0.240	0.420-4.380
	Mean[a] (mg/kg)	[b]	0.470	1.173	0.393	1.077	0.047	0.179	1.174
Nickel	Frequency of Detection	4/4	4/4	6/6	3/3	3/3	4/4	4/4	2/2
	Range (mg/kg)	9.220-64.530	35.600-608.90	28.610-503.97	20.670-49.730	52.550-202.00	7.700-51.390	8.910-59.730	46.620-66.950
	Mean[a] (mg/kg)	30.173	107.09	87.843	28.462	130.75	21.773	16.947	[b]
Potassium	Frequency of Detection	5/5	4/4	6/6	3/3	6/6	1/1	6/6	3/3
	Range (mg/kg)	16548-2564.1	795.60-4318.5	810.24-2894.0	892.15-1920.0	611.10-1490.0	913.15-913.15	485.94-1451.8	1690.0-2707.2
	Mean[a] (mg/kg)	1077.5	2382.1	1893.9	1378.1	1167.9	[b]	876.49	2100.6

See footnotes at end of table.

TABLE 4-75A (Continued)

Chemical	Parameter	Waste Pit 1	Waste Pit 2	Waste Pit 3	Waste Pit 4	Waste Pit 5	Waste Pit 6	Burn Pit	Clearwell
Selenium	Frequency of Detection	ND	3/3	3/3	ND	3/3	ND	ND	1/1
	Range (mg/kg)	ND	1.590-10.910	3.050-89.800	ND	2.800-7.470	ND	ND	3.720-3.720
	Mean[a] (mg/kg)	ND	3.002	50.917	ND	4.623	ND	ND	[b]
Silver	Frequency of Detection	3/3	2/2	4/4	3/3	2/2	1/1	2/2	1/1
	Range (mg/kg)	2.250-33.090	11.110-23.160	3.540-8.110	3.820-443.65	8.180-9.400	158.10-158.10	6.840-506.05	3.300-3.300
	Mean[a] (mg/kg)	7.367	[b]	6.555	151.24	[b]	[b]	[b]	[b]
Sodium	Frequency of Detection	4/4	4/4	6/6	4/4	6/6	1/1	4/4	3/3
	Range (mg/kg)	386.12-3638.6	479.75-2303.2	1291.3-7640.0	254.90-1237.6	1425.9-9980.0	600.07-600.07	355.52-1265.1	1293.4-2810.1
	Mean[a] (mg/kg)	1074.2	1165.2	2807.6	589.28	5416.9	[b]	851.12	2131.7
Thallium	Frequency of Detection	ND	ND	2/2	ND	1/1	ND	ND	ND
	Range (mg/kg)	ND	ND	5.890-12.210	ND	2.800-2.800	ND	ND	ND
	Mean[a] (mg/kg)	ND	ND	[b]	ND	[b]	ND	ND	ND
Vanadium	Frequency of Detection	4/4	4/4	6/6	3/3	6/6	1/1	6/6	3/3
	Range (mg/kg)	13.740-66.740	38.120-105.94	50.060-9695.5	24.040-235.36	791.98-5380.0	100.18-100.18	15.960-289.53	148.34-2596.1
	Mean[a] (mg/kg)	29.811	55.080	870.29	95.047	2698.9	[b]	29.504	385.35
Zinc	Frequency of Detection	3/3	4/4	6/6	4/4	6/6	4/4	6/6	3/3
	Range (mg/kg)	10.110-57.910	53.580-3247.2	44.560-311.19	13.920-84.060	116.92-212.00	4.800-151.00	14.530-74.660	81.810-194.35
	Mean[a] (mg/kg)	33.373	216.98	129.93	44.035	175.10	33.885	42.175	111.94

See footnotes at end of table.

TABLE 4-75A (Continued)

Chemical	Parameter	Active Flyash Pile	Inactive Flyash Pile	South Field Area	Solid Waste Landfill	North Lime Sludge Pond	South Lime Sludge Pond
Aluminum	Frequency of Detection	2/2	2/2	10/10	6/6	3/3	3/3
	Range (mg/kg)	3857.1-7027.4	6958.8-7557.8	6673.4-14636	6367.1-17247	9630.0-18600	4348.6-6015.6
	Mean[a] (mg/kg)	[b]	[b]	10200	10513	13843	5170.8
Arsenic	Frequency of Detection	2/2	2/2	10/10	5/5	3/3	ND
	Range (mg/kg)	4.640-5.330	10.760-31.170	3.700-7.060	3.280-6.690	6.300-16.000	ND
	Mean[a] (mg/kg)	[b]	[b]	5.144	5.166	11.433	ND
Barium	Frequency of Detection	ND	2/2	9/9	5/5	ND	1/1
	Range (mg/kg)	ND	205.08-271.04	48.370-118.92	67.580-124.13	ND	73.340-73.340
	Mean[a] (mg/kg)	ND	[b]	74.804	91.590	ND	[b]
Beryllium	Frequency of Detection	ND	1/1	1/1	ND	ND	ND
	Range (mg/kg)	ND	1.430-1.430	1.500-1.500	ND	ND	ND
	Mean[a] (mg/kg)	ND	[b]	[b]	ND	ND	ND
Cadmium	Frequency of Detection	2/2	2/2	10/10	6/6	ND	ND
	Range (mg/kg)	2.360-3.250	2.430-3.820	2.120-5.150	1.920-5.330	ND	ND
	Mean[a] (mg/kg)	[b]	[b]	3.547	3.098	ND	ND
Calcium	Frequency of Detection	2/2	2/2	10/10	6/6	3/3	3/3
	Range (mg/kg)	88166-140331	12070-54216	3622.2-187187	157.14-129975	252000-262000	298312-333762
	Mean[a] (mg/kg)	[b]	[b]	68916	63748	258000	311551

See footnotes at end of table.

TABLE 4-75A (Continued)

Chemical	Parameter	Active Flyash Pile	Inactive Flyash Pile	South Field Area	Solid Waste Landfill	North Lime Sludge Pond	South Lime Sludge Pond
Chromium	Frequency of Detection	2/2	2/2	10/10	6/6	ND	3/3
	Range (mg/kg)	7.950-12.620	12.440-15.790	9.360-21.690	9.230-21.300	ND	5.040-6.860
	Mean[a] (mg/kg)	[b]	[b]	15.552	16.548	ND	5.957
Cobalt	Frequency of Detection	ND	ND	5/5	ND	ND	ND
	Range (mg/kg)	ND	ND	9.760-27.730	ND	ND	ND
	Mean[a] (mg/kg)	ND	ND	14.293	-	ND	ND
Copper	Frequency of Detection	2/2	2/2	10/10	6/6	3/3	1/1
	Range (mg/kg)	8.620-9.030	22.450-23.450	9.570-23.240	11.150-29.630	15.000-24.000	12.010-12.010
	Mean[a] (mg/kg)	[b]	[b]	14.624	17.060	19.667	[b]
Iron	Frequency of Detection	2/2	2/2	10/10	6/6	3/3	3/3
	Range (mg/kg)	9.290-12.550	7281.9-14808	12798-23843	13467-21845	8990.0-20600	5041.6-6936.1
	Mean[a] (mg/kg)	[b]	[b]	17866	17139	14730	6051.7
Lead	Frequency of Detection	2/2	2/2	10/10	6/6	ND	1/1
	Range (mg/kg)	9.290-12.550	13.780-55.950	10.350-32.980	10.080-19.040	ND	2.140-2.140
	Mean[a] (mg/kg)	[b]	[b]	17.326	14.187	ND	[b]
Magnesium	Frequency of Detection	2/2	2/2	10/10	6/6	3/3	3/3
	Range (mg/kg)	24919-32006	3305.5-8523.9	2828.9-30281	7367.2-30105	19100-21200	15141-17982
	Mean[a] (mg/kg)	[b]	[b]	18597	18853	20000	16884

See footnotes at end of table.

TABLE 4-75A (Continued)

Chemical	Parameter	Active Flyash Pile	Inactive Flyash Pile	South Field Area	Solid Waste Landfill	North Lime Sludge Pond	South Lime Sludge Pond
Manganese	Frequency of Detection	2/2	2/2	10/10	6/6	3/3	3/3
	Range (mg/kg)	462.88-645.00	238.04-780.11	319.16-1165.7	247.58-716.45	546.00-638.00	694.80-746.77
	Mean[a] (mg/kg)	[b]	[b]	603.19	494.16	600.33	719.62
Mercury	Frequency of Detection	2/2	2/2	8/8	3/3	2/2	ND
	Range (mg/kg)	0.160-1.780	0.150-0.260	0.120-1.220	0.140-0.200	0.300-0.300	ND
	Mean[a] (mg/kg)	[b]	[b]	0.336	0.167	[b]	ND
Nickel	Frequency of Detection	1/1	2/2	10/10	6/6	ND	ND
	Range (mg/kg)	13.250-13.250	12.200-13.250	10.220-48.320	12.730-42.350	ND	ND
	Mean[a] (mg/kg)	[b]	[b]	23.416	19.552	ND	ND
Potassium	Frequency of Detection	2/2	1/1	10/10	6/6	3/3	2/2
	Range (mg/kg)	631.20-752.50	1076.9-1076.9	348.48-1503.6	491.92-1971.2	695.00-1670.0	216.00-343.20
	Mean[a] (mg/kg)	[b]	[b]	876.40	748.48	1145.0	[b]
Sodium	Frequency of Detection	1/1	2/2	2/2	2/2	3/3	ND
	Range (mg/kg)	129.00-129.00	167.51-189.35	135.72-138.78	162.33-180.24	304.00-1530.0	ND
	Mean[a] (mg/kg)	[b]	[b]	[b]	[b]	593.73	ND
Vanadium	Frequency of Detection	2/2	2/2	10/10	6/6	ND	ND
	Range (mg/kg)	13.110-20.190	26.320-29.480	15.080-31.910	12.110-26.630	ND	ND
	Mean[a] (mg/kg)	[b]	[b]	21.243	18.295	ND	ND

See footnotes at end of table.

TABLE 4-75A (Continued)

Chemical	Parameter	Active Flyash Pile	Inactive Flyash Pile	South Field Area	Solid Waste Landfill	North Lime Sludge Pond	South Lime Sludge Pond
Zinc	Frequency of Detection	2/2	2/2	10/10	6/6	3/3	3/3
	Range (mg/kg)	30.310-42.080	36.240-46.420	34.260-67.010	39.610-166.72	38.000-75.000	14.400-16.590
	Mean[a] (mg/kg)	[b]	[b]	47.678	64.480	50.430	15.820

[a]If number of detects <7 or frequency of detection <50%, a geometric mean is given, otherwise, an arithmetic mean is given.
[b]Not applicable if sample size ≤2.
[c]ND, not detected.

See footnotes at end of table.

TABLE 4-75B
ORGANIC CHEMICALS DETECTED DURING CIS SUBSURFACE SOIL SAMPLING

Chemical		Waste Pit 1	Waste Pit 2	Waste Pit 3	Waste Pit 4	Waste Pit 5	Waste Pit 6	Burn Pit	Clearwell
1,1,1-trichloroethane	Frequency of Detection	1/1	1/1	ND	1/1	ND	ND	ND	ND
	Range (mg/kg)	0.120-0.120	0.150-0.150	ND	0.120-0.120	ND	ND	ND	ND
	Mean[a] (mg/kg)	[b]	[b]	ND	[b]	ND	ND	ND	ND
1,1,2,2-tetrachloroethane	Frequency of Detection	ND[c]	ND	ND	ND	ND	1/1	ND	ND
	Range (mg/kg)	ND	ND	ND	ND	ND	29.000-29.000	ND	ND
	Mean[a] (mg/kg)	ND	ND	ND	ND	ND	[b]		
2-butanone	Frequency of Detection	5/5	2/2	1/1	2/2	ND	3/3	1/1	ND
	Range (mg/kg)	1.900-3.800	2.600-2.700	3.600-3.600	0.100-7.900	ND	0.530-1.400	0.070-0.070	ND
	Mean[a] (mg/kg)	2.403	[b]	[b]	[b]	ND	1.043	[b]	ND
2-methylnaphthalene	Frequency of Detection	1/1	2/2	ND	ND	ND	ND	1/1	ND
	Range (mg/kg)	0.220-0.220	7.000-8.000	ND	ND	ND	ND	0.050-0.050	ND
	Mean[a] (mg/kg)	[b]	[b]	ND	ND	ND	ND	[b]	ND
2,4-dimethylphenol	Frequency of Detection	ND	1/1	ND	ND	ND	ND	ND	ND
	Range (mg/kg)	ND	0.150-0.150	ND	ND	ND	ND	ND	ND
	Mean[a] (mg/kg)	ND	[b]	ND	ND	ND	ND	ND	ND
3,3'-dichlorobenzidine	Frequency of Detection	1/1	ND	ND	ND	ND	ND	ND	ND
	Range (mg/kg)	0.130-0.130	ND	ND	ND	ND	ND	ND	ND
	Mean[a] (mg/kg)	[b]	ND	ND	ND	ND	ND	ND	ND
4-chlorophenylphenyl-ether	Frequency of Detection	ND	1/1	ND	ND	ND	ND	ND	ND
	Range (mg/kg)	ND	62.000-62.000	ND	ND	ND	ND	ND	ND

See footnotes at end of table.

Table 4-75B
(Continued)

Chemical		Waste Pit 1	Waste Pit 2	Waste Pit 3	Waste Pit 4	Waste Pit 5	Waste Pit 6	Burn Pit	Clearwell
	Mean[a] (mg/kg)	ND	[b]	ND	ND	ND	ND	ND	ND
4-methylphenol	Frequency of Detection	ND	1/1	ND	ND	ND	ND	ND	ND
	Range (mg/kg)	ND	0.350-0.350	ND	ND	ND	ND	ND	ND
	Mean[a] (mg/kg)	ND	[b]	ND	ND	ND	ND	ND	ND
4,4-DDT	Frequency of Detection	1/1	2/2	ND	ND	ND	ND	ND	ND
	Range (mg/kg)	1.600-1.600	0.580-1.400	ND	ND	ND	ND	ND	ND
	Mean[a] (mg/kg)	[b]	[b]	ND	ND	ND	ND	ND	ND
Acenaphthrene	Frequency of Detection	ND	3/3	ND	2/2	ND	ND	ND	ND
	Range (mg/kg)	ND	0.080-50.000	ND	0.087-0.170	ND	ND	ND	ND
	Mean[a] (mg/kg)	ND	[b]	ND	[b]	ND	ND	ND	ND
Acetone	Frequency of Detection	5/5	2/2	6/6	3/3	2/2	4/4	5/5	3/3
	Range (mg/kg)	0.058-0.340	0.230-0.540	0.091-0.390	0.130-0.520	0.470-0.630	0.760-3.200	0.170-0.380	0.640-1.800
	Mean[a] (mg/kg)	0.236	[b]	0.156	0.333	[b]	1.790	0.228	1.413
Anthracene	Frequency of Detection	1/1	3/3	ND	2/2	ND	ND	ND	ND
	Range (mg/kg)	0.074-0.074	0.058-120.00	ND	0.260-0.510	ND	ND	ND	ND
	Mean[a] (mg/kg)	[b]	[b]	ND	[b]	ND	ND	ND	ND

See footnotes at end of table.

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Table 4-75B
(Continued)

Chemical		Waste Pit 1	Waste Pit 2	Waste Pit 3	Waste Pit 4	Waste Pit 5	Waste Pit 6	Burn Pit	Clearwell
Aroclor-1016	Frequency of Detection	ND	ND	ND	ND	ND	ND	1/1	ND
	Range (mg/kg)	ND	ND	ND	ND	ND	ND	0.290-0.290	ND
	Mean[a] (mg/kg)	ND	ND	ND	ND	ND	ND	[b]	ND
Aroclor-1242	Frequency of Detection	1/1	ND	ND	2/2	ND	ND	2/2	ND
	Range (mg/kg)	3.500-3.500	ND	ND	0.099-1.034	ND	ND	0.070-0.290	ND
	Mean[a] (mg/kg)	[b]	ND	ND	[b]	ND	ND	[b]	ND
Aroclor-1248	Frequency of Detection	ND	1/1	ND	2/2	2/2	ND	1/1	1/1
	Range (mg/kg)	ND	0.321-0.321	ND	0.460-0.854	0.330-0.550	ND	0.200-0.200	0.308-0.308
	Mean[a] (mg/kg)	ND	[b]	ND	[b]	[b]	ND	[b]	[b]
Aroclor-1254	Frequency of Detection	5/5	1/1	6/6	3/3	2/2	1/1	3/3	3/3
	Range (mg/kg)	0.720-10.000	0.323-0.323	0.074-0.550	0.296-1.008	0.330-0.750	0.081-0.081	0.077-2.700	0.132-0.737
	Mean[a] (mg/kg)	4.588	[b]	0.137	0.609	[b]	[b]	1.578	0.244
Aroclor-1260	Frequency of Detection	1/1	2/2	ND	ND	ND	ND	ND	ND
	Range (mg/kg)	7.000-7.000	0.740-1.800	ND	ND	ND	ND	ND	ND
	Mean[a] (mg/kg)	[b]	[b]	ND	ND	ND	ND	ND	ND
Benzo(a)anthracene	Frequency of Detection	2/2	5/5	1/1	3/3	ND	ND	4/4	1/1
	Range (mg/kg)	0.084-0.180	0.055-180.00	0.060-0.060	0.052-0.750	ND	ND	0.061-0.170	0.140-0.140
	Mean[a] (mg/kg)	[b]	2.973	[b]	0.397	ND	ND	0.092	[b]

See footnotes at end of table.

Table 4-75B
(Continued)

Chemical		Waste Pit 1	Waste Pit 2	Waste Pit 3	Waste Pit 4	Waste Pit 5	Waste Pit 6	Burn Pit	Clearwell
Benzo(a)pyrene	Frequency of Detection	1/1	4/4	ND	2/2	ND	ND	1/1	ND
	Range (mg/kg)	0.140-0.140	0.110-140.00	ND	0.320-0.550	ND	ND	0.160-0.160	ND
	Mean[a] (mg/kg)	[b]	65.203	ND	[b]	ND	ND	[b]	ND
Benzo(b)fluoranthene	Frequency of Detection	4/4	4/4	1/1	2/2	ND	ND	4/4	ND
	Range (mg/kg)	0.055-0.300	0.110-110.00	0.110-0.110	0.250-0.510	ND	ND	0.069-0.170	ND
	Mean[a] (mg/kg)	0.143	1.134	[b]	[b]	ND	ND	0.099	ND
Benzo(g,h,i)perylene	Frequency of Detection	ND	3/3	ND	3/3	ND	ND	1/1	ND
	Range (mg/kg)	ND	0.290-52.000	ND	0.065-0.170	ND	ND	0.085-0.085	ND
	Mean[a] (mg/kg)	ND	31.430	ND	0.122	ND	ND	[b]	ND
Benzo(k)fluoranthene	Frequency of Detection	1/1	4/4	ND	2/2	ND	ND	ND	ND
	Range (mg/kg)	0.140-0.140	0.180-120.00	ND	0.330-0.560	ND	ND	ND	ND
	Mean[a] (mg/kg)	[b]	48.945	ND	[b]	ND	ND	ND	ND
Bis(2-ethyl-hexyl)phthalate	Frequency of Detection	2/2	1/1	6/6	2/2	5/5	2/2	4/4	2/2
	Range (mg/kg)	0.330-1.700	0.360-0.360	0.110-1.100	0.140-0.270	0.084-2.300	0.410-0.910	0.340-2.000	0.200-0.270
	Mean[a] (mg/kg)	[b]	[b]	0.480	[b]	0.387	[b]	0.731	[b]
Chloroform	Frequency of Detection	3/3	ND	ND	4/4	ND	ND	ND	ND
	Range (mg/kg)	0.067-0.210	ND	ND	0.040-1.300	ND	ND	ND	ND
	Mean[a] (mg/kg)	0.142	ND	ND	0.209	ND	ND	ND	ND

See footnotes at end of table.

Table 4-75B
(Continued)

Chemical		Waste Pit 1	Waste Pit 2	Waste Pit 3	Waste Pit 4	Waste Pit 5	Waste Pit 6	Burn Pit	Clearwell
Chrysene	Frequency of Detection	4/4	4/4	1/1	4/4	ND	ND	3/3	2/2
	Range (mg/kg)	0.064-0.510	0.074-180.00	0.075-0.075	0.070-0.760	ND	ND	0.073-0.083	0.074-0.150
	Mean[a] (mg/kg)	0.249	1.296	[b]	0.503	ND	ND	0.078	[b]
Dibenzo(a,h)anthracene	Frequency of Detection	ND	1/1	ND	2/2	ND	ND	ND	ND
	Range (mg/kg)	ND	16.000-16.000	ND	0.065-0.170	ND	ND	ND	ND
	Mean[a] (mg/kg)	ND	[b]	ND	[b]	ND	ND	ND	ND
Dibenzofuran	Frequency of Detection	ND	2/2	ND	2/2	ND	ND	ND	ND
	Range (mg/kg)	ND	0.078-36.000	ND	0.098-0.160	ND	ND	ND	ND
	Mean[a] (mg/kg)	ND	[b]	ND	[b]	ND	ND	ND	ND
Di-n-butyl phthalate	Frequency of Detection	4/4	3/3	3/3	2/2	3/3	ND	3/3	1/1
	Range (mg/kg)	0.068-0.092	0.096-0.380	0.084-0.084	0.060-0.490	0.056-0.250	ND	0.054-0.210	0.120-0.120
	Mean[a] (mg/kg)	0.083	0.168	0.084	[b]	0.169	ND	0.092	[b]
Di-n-octyl phthalate	Frequency of Detection	4/4	4/4	ND	1/1	ND	ND	4/4	ND
	Range (mg/kg)	0.150-0.830	0.096-0.570	ND	0.170-0.170	ND	ND	0.067-0.130	ND
	Mean[a] (mg/kg)	0.284	0.282	ND	[b]	ND	ND	0.084	ND
Ethylbenzene	Frequency of Detection	2/2	1/1	ND	ND	ND	ND	1/1	ND
	Range (mg/kg)	0.040-0.055	0.048-0.048	ND	ND	ND	ND	0.270-0.270	ND
	Mean[a] (mg/kg)	[b]	[b]	ND	ND	ND	ND	[b]	ND

See footnotes at end of table.

Table 4-75B
(Continued)

Chemical		Waste Pit 1	Waste Pit 2	Waste Pit 3	Waste Pit 4	Waste Pit 5	Waste Pit 6	Burn Pit	Clearwell
Ethyl parathion	Frequency of Detection	ND	ND	ND	3/3	ND	ND	ND	ND
	Range (mg/kg)	ND	ND	ND	0.082-0.860	ND	ND	ND	ND
	Mean[a] (mg/kg)	ND	ND	ND	0.220	ND	ND	ND	ND
Fluoranthene	Frequency of Detection	ND	4/4	1/1	4/4	ND	ND	5/5	ND
	Range (mg/kg)	ND	0.160-460.00	0.230-0.230	0.170-2.200	ND	ND	0.074-0.420	ND
	Mean[a] (mg/kg)	ND	3.161	[b]	1.393	ND	ND	0.221	ND
Fluorene	Frequency of Detection	ND	2/2	ND	2/2	ND	ND	ND	ND
	Range (mg/kg)	ND	0.150-62.000	ND	0.160-0.310	ND	ND	ND	ND
	Mean[a] (mg/kg)	ND	[b]	ND	[b]	ND	ND	ND	ND
Indeno(1,2,3-cd)pyrene	Frequency of Detection	ND	3/3	ND	3/3	ND	ND	1/1	ND
	Range (mg/kg)	ND	0.340-52.000	ND	0.150-0.180	ND	ND	0.078-0.078	ND
	Mean[a] (mg/kg)	ND	32.780	ND	0.170	ND	ND	[b]	ND
Malathion	Frequency of Detection	ND	ND	ND	1/1	ND	ND	ND	ND
	Range (mg/kg)	ND	ND	ND	0.670-0.670	ND	ND	ND	ND
	Mean[a] (mg/kg)	ND	ND	ND	[b]	ND	ND	ND	ND
Methylene chloride	Frequency of Detection	4/4	2/2	1/1	3/3	6/6	2/2	2/2	2/2
	Range (mg/kg)	0.140-0.180	0.170-0.200	0.420-0.420	0.370-2.100	0.042-0.420	0.280-0.700	0.100-0.140	0.380-0.640
	Mean[a] (mg/kg)	0.152	[b]	[b]	1.090	0.245	[b]	[b]	[b]

See footnotes at end of table.

Table 4-75B
(Continued)

Chemical		Waste Pit 1	Waste Pit 2	Waste Pit 3	Waste Pit 4	Waste Pit 5	Waste Pit 6	Burn Pit	Clearwell
Methyl parathion	Frequency of Detection	ND	ND	ND	2/2	ND	ND	ND	ND
	Range (mg/kg)	ND	ND	ND	0.170-0.230	ND	ND	ND	ND
	Mean[a] (mg/kg)	ND	ND	ND	[b]	ND	ND	ND	ND
Naphthalene	Frequency of Detection	1/1	2/2	ND	3/3	ND	ND	ND	ND
	Range (mg/kg)	0.054-0.054	0.190-16.000	ND	0.062-0.110	ND	ND	ND	ND
	Mean[a] (mg/kg)	[b]	[b]	ND	0.094	ND	ND	ND	ND
N-nitroso-diphenyl-amino(1)	Frequency of Detection	ND	ND	1/1	ND	ND	ND	ND	ND
	Range (mg/kg)	ND	ND	0.130-0.130	ND	ND	ND	ND	ND
	Mean[a] (mg/kg)	ND	ND	[b]	ND	ND	ND	ND	ND
Pentachlorophenol(2)	Frequency of Detection	ND	ND	2/2	ND	ND	ND	2/2	ND
	Range (mg/kg)	ND	ND	0.630-1.300	ND	ND	ND	1.200-2.600	ND
	Mean[a] (mg/kg)	ND	ND	[b]	ND	ND	ND	[b]	ND
Phenanthrene	Frequency of Detection	5/5	4/4	1/1	4/4	ND	ND	6/6	2/2
	Range (mg/kg)	0.097-2.300	0.098-370.00	0.120-0.120	0.110-2.100	ND	ND	0.049-0.290	0.068-0.240
	Mean[a] (mg/kg)	0.359	2.228	[b]	1.328	ND	ND	0.155	[b]
Phenol	Frequency of Detection	ND	1/1	ND	2/2	1/1	ND	2/2	ND
	Range (mg/kg)	ND	0.330-0.330	ND	0.430-0.830	0.200-0.200	ND	0.140-0.650	ND
	Mean[a] (mg/kg)	ND	[b]	ND	[b]	[b]	ND	[b]	ND

See footnotes at end of table.

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Table 4-75B
(Continued)

Chemical		Waste Pit 1	Waste Pit 2	Waste Pit 3	Waste Pit 4	Waste Pit 5	Waste Pit 6	Burn Pit	Clearwell
Pyrene	Frequency of Detection	5/5	4/4	1/1	4/4	ND	ND	5/5	1/1
	Range (mg/kg)	0.072-0.360	0.088-310.00	0.190-0.190	0.093-1.400	ND	ND	0.079-0.250	0.290-0.290
	Mean[a] (mg/kg)	0.166	2.069	[b]	0.891	ND	ND	0.144	[b]
Tetrachloroethene	Frequency of Detection	1/1	ND	ND	2/2	ND	ND	2/2	ND
	Range (mg/kg)	0.075-0.075	ND	ND	0.530-30.000	ND	ND	0.170-0.260	ND
	Mean[a] (mg/kg)	[b]	ND	ND	[b]	ND	ND	[b]	ND
Toluene	Frequency of Detection	3/3	ND	ND	2/2	ND	1/1	1/1	ND
	Range (mg/kg)	0.040-0.096	ND	ND	0.060-0.067	ND	0.440-0.440	0.050-0.050	ND
	Mean[a] (mg/kg)	0.057	ND	ND	[b]	ND	[b]	[b]	ND
Total xylenes	Frequency of Detection	ND	1/1	ND	ND	ND	3/3	1/1	ND
	Range (mg/kg)	ND	0.260-0.260	ND	ND	ND	0.460-0.750	0.890-0.890	ND
	Mean[a] (mg/kg)	ND	[b]	ND	ND	ND	0.627	[b]	ND
Trans 1,2-dichloroethene	Frequency of Detection	ND	ND	ND	1/1	ND	ND	ND	ND
	Range (mg/kg)	ND	ND	ND	0.060-0.060	ND	ND	ND	ND
	Mean[a] (mg/kg)	ND	ND	ND	[b]	ND	ND	ND	ND
Trichloroethene	Frequency of Detection	ND	ND	ND	1/1	ND	1/1	ND	ND
	Range (mg/kg)	ND	ND	ND	0.300-0.300	ND	0.170-0.170	ND	ND
	Mean[a] (mg/kg)	ND	ND	ND	[b]	ND	[b]	ND	ND

See footnotes at end of table.

Table 4-75B
(Continued)

Chemical		Waste Pit 1	Waste Pit 2	Waste Pit 3	Waste Pit 4	Waste Pit 5	Waste Pit 6	Burn Pit	Clearwell
Unknown hydrocarbon	Frequency of Detection	ND	ND	ND	ND	1/1	ND	ND	ND
	Range (mg/kg)	ND	ND	ND	ND	0.420-0.420	ND	ND	ND
	Mean[a] (mg/kg)	ND	ND	ND	ND	[b]	ND	ND	ND
Unknown-c10 cyclic hydrocarbon	Frequency of Detection	ND	ND	ND	ND	1/1	ND	ND	ND
	Range (mg/kg)	ND	ND	ND	ND	0.240-0.240	ND	ND	ND
	Mean[a] (mg/kg)	ND	ND	ND	ND	[b]	ND	ND	ND
Vinyl chloride	Frequency of Detection	ND	1/1	ND	ND	ND	ND	ND	ND
	Range (mg/kg)	ND	0.670-0.670	ND	ND	ND	ND	ND	ND
	Mean[a] (mg/kg)	ND	[b]	ND	ND	ND	ND	ND	ND

		Active Flyash Pile	Inactive Flyash Pile	South Field Area	Solid Waste Landfill	North Lime Sludge Pond	South Lime Sludge Pond
1,1,2-trichloro-1,2,2-trifluoroethane	Frequency of Detection	ND	ND	ND	ND	2/2	ND
	Range (mg/kg)	ND	ND	ND	ND	0.050-0.081	ND
	Mean[a] (mg/kg)	ND	ND	ND	ND	[b]	ND
1,1-dichloroethane	Frequency of Detection	ND	ND	ND	ND	1/1	ND
	Range (mg/kg)	ND	ND	ND	ND	0.003-0.003	ND
	Mean[a] (mg/kg)	ND	ND	ND	ND	[b]	ND
2,4-dimethylphenol	Frequency of Detection	ND	ND	ND	1/1	ND	ND
	Range (mg/kg)	ND	ND	ND	0.240-0.240	ND	ND
	Mean[a] (mg/kg)	ND	ND	ND	[b]	ND	ND

See footnotes at end of table.

Table 4-75B
(Continued)

		Active Flyash Pile	Inactive Flyash Pile	South Field Area	Solid Waste Landfill	North Lime Sludge Pond	South Lime Sludge Pond
2-butanone	Frequency of Detection	ND	ND	ND	1/1	ND	1/1
	Range (mg/kg)	ND	ND	ND	0.120-0.120	ND	1.800-1.800
	Mean[a] (mg/kg)	ND	ND	ND	[b]	ND	[b]
2-methyl-naphthalene	Frequency of Detection	ND	ND	ND	3/3	ND	ND
	Range (mg/kg)	ND	ND	ND	0.066-11.000	ND	ND
	Mean[a] (mg/kg)	ND	ND	ND	0.928	ND	ND
2-methyl-phenol	Frequency of Detection	ND	ND	ND	1/1	ND	ND
	Range (mg/kg)	ND	ND	ND	0.096-0.096	ND	ND
	Mean[a] (mg/kg)	ND	ND	ND	[b]	ND	ND
4-methylphenol	Frequency of Detection	ND	ND	ND	1/1	ND	ND
	Range (mg/kg)	ND	ND	ND	0.360-0.360	ND	ND
	Mean[a] (mg/kg)	ND	ND	ND	[b]	ND	ND
Acenaphthene	Frequency of Detection	ND	ND	ND	3/3	ND	ND
	Range (mg/kg)	ND	ND	ND	1.300-28,000	ND	ND
	Mean[a] (mg/kg)	ND	ND	ND	4.105	ND	ND

See footnotes at end of table.

Table 4-75B
(Continued)

		Active Flyash Pile	Inactive Flyash Pile	South Field Area	Solid Waste Landfill	North Lime Sludge Pond	South Lime Sludge Pond
Acetone	Frequency of Detection	1/1	ND	3/3	6/6	4/4	2/2
	Range (mg/kg)	0.200-0.200	ND	0.230-0.250	0.130-0.250	0.020-0.150	0.090-0.140
	Mean[a] (mg/kg)	[b]	ND	0.240	0.173	0.113	[b]
Anathracene	Frequency of Detection	ND	ND	ND	4/4	ND	ND
	Range (mg/kg)	ND	ND	ND	0.085-2.800	ND	ND
	Mean[a] (mg/kg)	ND	ND	ND	1.871	ND	ND
Aroclor-1242	Frequency of Detection	ND	1/1	4/4	5/5	ND	ND
	Range (mg/kg)	ND	0.006-0.006	0.002-0.093	0.078-1.600	ND	ND
	Mean[a] (mg/kg)	ND	[b]	0.053	0.215	ND	ND
Aroclor-1248	Frequency of Detection	ND	ND	ND	2/2	1/1	ND
	Range (mg/kg)	ND	ND	ND	0.180-0.565	1.200-1.200	ND
	Mean[a] (mg/kg)	ND	ND	ND	[b]	[b]	ND
Aroclor-1254	Frequency of Detection	ND	1/1	7/7	1/1	ND	ND
	Range (mg/kg)	ND	0.290-0.290	0.039-0.880	0.719-0.719	ND	ND
	Mean[a] (mg/kg)	ND	[b]	0.391	[b]	ND	ND

See footnotes at end of table.

Table 4-75B
(Continued)

		Active Flyash Pile	Inactive Flyash Pile	South Field Area	Solid Waste Landfill	North Lime Sludge Pond	South Lime Sludge Pond
Aroclor-1260	Frequency of Detection	1/1	ND	3/3	ND	ND	ND
	Range (mg/kg)	0.038-0.038	ND	0.028-0.420	ND	ND	ND
	Mean[a] (mg/kg)	[b]	ND	0.233	ND	ND	ND
Benzo(a)anthracene	Frequency of Detection	ND	ND	ND	4/4	ND	ND
	Range (mg/kg)	ND	ND	ND	0.130-5.100	ND	ND
	Mean[a] (mg/kg)	ND	ND	ND	0.659	ND	ND
Benzo(a)pyrene	Frequency of Detection	ND	ND	ND	5/5	ND	ND
	Range (mg/kg)	ND	ND	ND	0.100-7.000	ND	ND
	Mean[a] (mg/kg)	ND	ND	ND	0.948	ND	ND
Benzo(b)fluoranthene	Frequency of Detection	ND	ND	ND	4/4	ND	ND
	Range (mg/kg)	ND	ND	ND	0.098-6.700	ND	ND
	Mean[a] (mg/kg)	ND	ND	ND	0.622	ND	ND
Benzo(g,h,i)perylene	Frequency of Detection	ND	ND	ND	5/5	ND	ND
	Range (mg/kg)	ND	ND	ND	0.110-6.000	ND	ND
	Mean[a] (mg/kg)	ND	ND	ND	2.722	ND	ND

See footnotes at end of table.

Table 4-75B
(Continued)

		Active Flyash Pile	Inactive Flyash Pile	South Field Area	Solid Waste Landfill	North Lime Sludge Pond	South Lime Sludge Pond
Benzo(k)fluoranthene	Frequency of Detection	ND	ND	ND	5/5	ND	ND
	Range (mg/kg)	ND	ND	ND	0.084-4.900	ND	ND
	Mean[a] (mg/kg)	ND	ND	ND	2.199	ND	ND
Benzoic acid(2)	Frequency of Detection	ND	ND	ND	ND	ND	1/1
	Range (mg/kg)	ND	ND	ND	ND	ND	0.230-0.230
	Mean[a] (mg/kg)	ND	ND	ND	ND	ND	[b]
Bis(2-ethyl-hexyl)phthalate	Frequency of Detection	ND	ND	ND	2/2	3/3	3/3
	Range (mg/kg)	ND	ND	ND	0.049-0.150	0.150-0.310	0.230-0.310
	Mean[a] (mg/kg)	ND	ND	ND	[b]	0.203	0.260
Butyl benzylphthalate	Frequency of Detection	ND	ND	ND	1/1	ND	ND
	Range (mg/kg)	ND	ND	ND	0.320-0.320	ND	ND
	Mean[a] (mg/kg)	ND	ND	ND	[b]	ND	ND
Carbon disulfide	Frequency of Detection	ND	ND	ND	ND	3/3	ND
	Range (mg/kg)	ND	ND	ND	ND	0.007-0.009	ND
	Mean[a] (mg/kg)	ND	ND	ND	ND	0.008	ND

See footnotes at end of table.

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Table 4-75B
(Continued)

		Active Flyash Pile	Inactive Flyash Pile	South Field Area	Solid Waste Landfill	North Lime Sludge Pond	South Lime Sludge Pond
Chlordane	Frequency of Detection	ND	ND	ND	ND	1/1	ND
	Range (mg/kg)	ND	ND	ND	ND	1.200-1.200	ND
	Mean[a] (mg/kg)	ND	ND	ND	ND	[b]	ND
Chrysene	Frequency of Detection	ND	ND	ND	3/3	ND	ND
	Range (mg/kg)	ND	ND	ND	0.170-4.600	ND	ND
	Mean[a] (mg/kg)	ND	ND	ND	2.223	ND	ND
Di-n-butyl phthalate	Frequency of Detection	ND	ND	ND	3/3	3/3	2/2
	Range (mg/kg)	ND	ND	ND	0.050-0.330	0.089-0.120	0.047-0.073
	Mean[a] (mg/kg)	ND	ND	ND	0.145	0.101	[b]
Di-n-octyl phthalate	Frequency of Detection	ND	ND	ND	2/2	ND	ND
	Range (mg/kg)	ND	ND	ND	0.300-0.350	ND	ND
	Mean[a] (mg/kg)	ND	ND	ND	[b]	ND	ND
Dibenzo(a,h)anthracene	Frequency of Detection	ND	ND	ND	3/3	ND	ND
	Range (mg/kg)	ND	ND	ND	0.560-2.100	ND	ND
	Mean[a] (mg/kg)	ND	ND	ND	1.253	ND	ND

See footnotes at end of table.

Table 4-75B
(Continued)

		Active Flyash Pile	Inactive Flyash Pile	South Field Area	Solid Waste Landfill	North Lime Sludge Pond	South Lime Sludge Pond
Dibenzofuran	Frequency of Detection	ND	ND	ND	4/4	ND	ND
	Range (mg/kg)	ND	ND	ND	0.620-1.900	ND	ND
	Mean[a] (mg/kg)	ND	ND	ND	1.480	ND	ND
Ethylbenzene	Frequency of Detection	ND	ND	ND	1/1	ND	ND
	Range (mg/kg)	ND	ND	ND	0.091-0.091	ND	ND
	Mean[a] (mg/kg)	ND	ND	ND	[b]	ND	ND
Fluoranthene	Frequency of Detection	ND	ND	ND	3/3	ND	ND
	Range (mg/kg)	ND	ND	ND	0.330-1.900	ND	ND
	Mean[a] (mg/kg)	ND	ND	ND	0.893	ND	ND
Fluorene	Frequency of Detection	ND	ND	ND	3/3	ND	ND
	Range (mg/kg)	ND	ND	ND	1.400-2.500	ND	ND
	Mean[a] (mg/kg)	ND	ND	ND	1.933	ND	ND
Indeno(1,2,3-cd)pyrene	Frequency of Detection	ND	ND	ND	4/4	ND	ND
	Range (mg/kg)	ND	ND	ND	0.081-5.700	ND	ND
	Mean[a] (mg/kg)	ND	ND	ND	2.570	ND	ND

See footnotes at end of table.

Table 4-75B
(Continued)

		Active Flyash Pile	Inactive Flyash Pile	South Field Area	Solid Waste Landfill	North Lime Sludge Pond	South Lime Sludge Pond
Methylene chloride	Frequency of Detection	1/1	ND	2/2	5/5	4/4	3/3
	Range (mg/kg)	0.100-0.100	ND	0.100-0.110	0.084-0.160	0.021-0.026	0.110-0.240
	Mean[a] (mg/kg)	[b]	ND	[b]	0.123	0.024	0.180
N-nitroso-diphenylamine(1)	Frequency of Detection	ND	ND	ND	1/1	ND	ND
	Range (mg/kg)	ND	ND	ND	0.067-0.067	ND	ND
	Mean[a] (mg/kg)	ND	ND	ND	[b]	ND	ND
Naphthalene	Frequency of Detection	ND	ND	ND	2/2	ND	ND
	Range (mg/kg)	ND	ND	ND	2.700-19.000	ND	ND
	Mean[a] (mg/kg)	ND	ND	ND	[b]	ND	ND
Phenanthrene	Frequency of Detection	ND	ND	ND	3/3	ND	ND
	Range (mg/kg)	ND	ND	ND	0.320-1.900	ND	ND
	Mean[a] (mg/kg)	ND	ND	ND	0.850	ND	ND
Phenol	Frequency of Detection	ND	ND	ND	ND	ND	1/1
	Range (mg/kg)	ND	ND	ND	ND	ND	0.089-0.089
	Mean[a] (mg/kg)	ND	ND	ND	ND	ND	[b]

See footnotes at end of table.

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Table 4-75B
(Continued)

		Active Flyash Pile	Inactive Flyash Pile	South Field Area	Solid Waste Landfill	North Lime Sludge Pond	South Lime Sludge Pond
Pyrene	Frequency of Detection	ND	ND	ND	4/4	ND	ND
	Range (mg/kg)	ND	ND	ND	0.240-6.300	ND	ND
	Mean[a] (mg/kg)	ND	ND	ND	0.964	ND	ND
Tetrachloroethene	Frequency of Detection	ND	ND	ND	1/1	ND	ND
	Range (mg/kg)	ND	ND	ND	0.097-0.097	ND	ND
	Mean[a] (mg/kg)	ND	ND	ND	[b]	ND	ND
Toluene	Frequency of Detection	ND	ND	ND	1/1	2/2	ND
	Range (mg/kg)	ND	ND	ND	0.180-0.180	0.020-0.020	ND
	Mean[a] (mg/kg)	ND	ND	ND	[b]	[b]	ND
Total xylenes	Frequency of Detection	ND	ND	ND	1/1	ND	ND
	Range (mg/kg)	ND	ND	ND	0.320-0.320	ND	ND
	Mean[a] (mg/kg)	ND	ND	ND	[b]	ND	ND
Unknown hydrocarbon	Frequency of Detection	ND	ND	ND	ND	1/1	ND
	Range (mg/kg)	ND	ND	ND	ND	0.130-0.130	ND
	Mean[a] (mg/kg)	ND	ND	ND	ND	[b]	ND

[a]If number of detects <7 or frequency of detection <50%, a geometric mean is given, otherwise, an arithmetic mean is given.
[b]Not applicable if sample size ≤2.
[c]ND, not detected.

See footnotes at end of table.

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concentrations exceeding 500 pCi/g. Technetium-99, Th-228, Th-232, U-236, and Ra-226 were also detected in mean concentrations above 30 pCi/g (Table 4-74).

Aluminum, calcium, iron and magnesium were present in the highest amounts among inorganics measured in Waste Pit 4. In the entire waste storage area, ethyl parathion, malathion, and methyl parathion were detected only in Waste Pit 4, as was the highest concentration of tetrachloroethene (Table 4-75B). Semivolatile compounds, including phenanthrene, fluoranthene, and pyrene, were also detected.

Isotopes of uranium and thorium, Tc-99 and Ra-226 had the highest concentrations of radionuclides in Waste Pit 5 (Table 4-74). Maximum activities included 1,250 pCi/g for U-234; 79 pCi/g for U-235; 1,230 pCi/g U-238; 191 pCi/g for Th-228; 20,200 pCi/g for Th-230; and 580 pCi/g for Th-232 (Table 4-74). Technetium-99 was detected in concentrations up to 2,990 pCi/g and Ra-226 was detected as high as 383 pCi/g. The highest concentrations of Pu-238, Pu-239/240, and Np-237 were found in Waste Pit 5.

As with the other pits, aluminum, calcium, iron and magnesium were the dominant inorganics present in Waste Pit 5. Barium, chromium, copper, and sodium were found in the highest quantities in Pit 5 (Table 4-75A). PCBs were detected, but few other organics were detected (Table 4-75B).

The highest concentration of U-238 in the waste pit area was in Waste Pit 6. Other radionuclides had above background levels, including U-234, U-235, Tc-99, Sr-90, Cs-137, Np-237, and thorium isotopes (Table 4-74).

Aluminum, calcium and magnesium were found in quantities exceeding 4,500 mg/kg in Waste Pit 6, with sixty mg/kg of lead and 158 mg/kg of silver also detected in samples (Table 4-75A). 1,1,2,2-tetrachloroethane was found in quantities up to 29,000 µg/kg. No detectable semivolatile organic compounds were found in Waste Pit 6 (Table 4-75B).

Uranium and thorium were the predominant radionuclides measured in the Burn Pit, with concentrations of U-234, U-238, and Th-230 over 200 pCi/g (Table 4-74). Mean concentrations of all other detected radionuclides fell below 10 pCi/g.

Aluminum, calcium, iron and magnesium were present in amounts over 6500 mg/kg in the Burn Pit (Table 4-75A). Traces of lead and silver were found in all the boreholes. PCBs and semivolatile organic compounds were detected in all the borings (Table 4-75B). Tetrachloroethene, a volatile compound, was detected in concentrations ranging from 170 to 260 µg/kg.

Uranium, thorium, Tc-99, Cs-137 and Ra-226 were the predominant radionuclides in the Clearwell.

Uranium-234 and U-238 were detected at up to 376 pCi/g and 670 pCi/g, respectively. Peak concentrations of other radionuclides include Th-230 at 5,600 pCi/g; Tc-99 at 322 pCi/g; Cs-137 at 450 pCi/g; and Ra-226 at 438 pCi/g (Table 4-74).

Aluminum, calcium, iron and magnesium were the principal inorganics detected in the Clearwell (Table 4-75A). Mercury was also detected in all samples from the Clearwell at 0.42 to 4.4 mg/kg. PCBs were detected, as were several other organic compounds (Table 4-75B).

Fewer radioisotopes were analyzed in the samples taken from the borings from the active and inactive fly ash disposal areas than in the waste pits, because there was no historical basis for suspecting the presence of activation or fission products. Radionuclide concentrations in the inactive fly ash disposal area were low, with no mean concentrations exceeding 10 pCi/g (Table 4-74). Uranium-238 was the predominant radionuclide present, but radioactivity was observed in a number of areas during the surface soil characterization (Section 4.1.5.4), suggesting that radioactivity associated with the flyash results from actions that occurred at irregular intervals as the fly ash disposal area was developed. All the radionuclides analyzed in samples from the active fly ash pile are very low in activity (Table 4-74).

Aluminum, calcium, iron and magnesium were found in concentrations exceeding 7,500 mg/kg in the inactive fly ash disposal area and the Southfield (Table 4-75A). Arsenic, cadmium, and lead were also detected in all of the boreholes, and mercury was detected in all but one boring. PCBs were detected in six boreholes, and qualitative amounts of PCBs were detected in all other boreholes (Table 4-75B). There were quantitative levels of aluminum, calcium, iron, magnesium, arsenic, cadmium, lead and mercury in samples from the active fly ash pile, as well as qualitative amounts of PCBs, in both boreholes (Tables 4-75A, B).

Uranium-238 was the only radionuclide detected in concentrations over 100 pCi/g in the solid waste landfill, at a maximum concentration of 338 pCi/g (Table 4-74). Mean concentrations of Th-230, Th-232 and U-234 over 1.0 pCi/g were also detected. The remaining radionuclides analyzed in the solid waste landfill were very low or below detection limits.

In the solid waste landfill, aluminum, calcium, iron and magnesium had the highest concentrations among inorganics (Table 4-75A). Traces of lead and cadmium were also found in each of the borings. Quantitative amounts of PCBs were detected in four of the six borings, while qualitative measurements of PCBs were found in the other two boreholes (Table 4-75B). Semivolatile organic compounds were detected in all the samples.

In the north and south lime sludge ponds, aluminum, calcium, iron and magnesium were detected in amounts over 6,000 mg/kg (Table 4-74). In the organics analysis, butyl benzyl phthalate was found in

peak concentrations of 2,800 g/kg in the north lime sludge pond (Table 4-75B). Samples containing chlordane and Aroclor 1248 were also obtained from the north pond. No volatile or semivolatile organics were detected in quantities over 250 µg/kg in the south lime sludge pond, with the exception of 2-butanone and bis(2-ethylhexyl)phthalate (Table 4-75B).

4.1.6.2 "FMPC Sampling and Analysis Report," DOE (1988)

Samples from the Southfield Area had above background levels of total uranium and other radionuclides in the subsurface soils (Table 4-76), with a maximum of 85.0 mg/kg. The radionuclide with the highest activity was U-238, which was detected in samples from all locations. Volatile organic compounds were detected in flyash samples from both the active and inactive fly ash piles (Table 4-76). Barium exceeded analytical detection limits in all samples but one from the Southfield and fly ash disposal areas, with a range of 0.25 to 1.22 mg/ℓ. Chromium was also detected in two samples.

Sites outside the production area had above background levels of total uranium and other radionuclides (Table 4-77). Uranium-238 was the most commonly detected radionuclide. Samples collected from the former incinerator area had the highest levels of both total U and U-238, 12,400 pCi/g and 2,399 pCi/g, respectively. Several volatile organic compounds were detected, but except for chloroform, were also detected in most of the blanks. Barium was detected in all samples, ranging from 0.06 to 0.95 mg/ℓ, while chromium was detected in samples from the fire training area and six backhoe trench samples in the Southfield, ranging from 0.03 to 0.05 mg/ℓ (Table 4-77).

4.1.6.3 FEMP Remedial Investigation/Feasibility Study

Tables 4-78, 4-79A, and 4-79B summarize the RI/FS data available on subsurface soil samples as of December 1, 1991. K-65 berm subsurface samples had above background levels of Ra-226 and Pb-210 (Table 4-78). Other radionuclides detected include Th-228, Th-230, U-234 and U-238. Samples from the K-65 slant borings had detectable Th-228, Th-230, U-234 and U-238 above background levels. The highest radionuclide concentrations in the slant boring samples were of U-234 and U-238 (Table 4-78).

There were higher levels of antimony in the K-65 berms than in any other borings in the waste storage area (Table 4-79A). Cyanide was also detected in four samples, with a maximum of 1,600 µg/kg. Methylene chloride was found in all samples, and multiple detection of other volatile organics include 2-butanone and acetone.

Radium-226, Ra-228, Th-228, Th-230, Th-232, U-234 and U-235 were consistently detected in samples from the waste pits (Table 4-78). The peak concentration for the most frequently detected radionuclides were: 1180 pCi/g for Ra-226, 165 pCi/g for Ra-228, 581 pCi/g for Th-228, 7597 pCi/g for Th-230, 761 pCi/g for Th-232, 429 pCi/g for U-234 and 1404 pCi/g for U-238.

TABLE 4-76
ANALYTE CONCENTRATIONS WHICH EXCEED MINIMUM DETECTION LIMITS
SUBSURFACE SOIL SAMPLES (DOE, 1988)

		RCRA Metals		Organics					
Sample Number	Location	Ba mg/L	Cr mg/L	1,1,1-Tri µg/kg	2-But µg/kg	Acet µg/kg	ChlF µg/kg	M Chl µg/kg	Tol µg/kg
FEO601WP1B	Active Flyash Pile	0.50		NS	NS	NS	NS	NS	NS
FEO602WP1B	Active Flyash Pile	0.34		NS	NS	NS	NS	NS	NS
FEO603WP1B	Active Flyash Pile	0.78	0.06	NS	NS	NS	NS	NS	NS
FEO604WP1B	Active Flyash Pile	0.61		NS	NS	NS	NS	NS	NS
FEO605WP1B	Active Flyash Pile	0.73		NS	NS	NS	NS	NS	NS
FEO607WP1B	Active Flyash Pile	0.37		NS	NS	NS	NS	NS	NS
FEO608WP1B	Active Flyash Pile	1.22		NS	NS	NS	NS	NS	NS
FEO609WP1B	Active Flyash Pile	1.15		NS	NS	NS	NS	NS	NS

Footnotes and Flags

Blank spaces indicate concentration below MDL.
B = analyte was found in the blank as well as the sample.
NS = sample not analyzed for indicated analyte.

Key to Organics Abbreviations

1,1,1-Tri--Trichloroethane; 2-But--2-Butanone; Acet--Acetone; ChlF--Chloroform; M Chl--Methylene Chloride; Tol--Toluene;

TABLE 4-76
(Continued)

Sample Number	Location	Radionuclides				
		Bi-214 pCi/g	Ra-226 pCi/g	Th-228 pCi/g	Th-232 pCi/g	Total U pCi/g
FEO601WP1B	Active Flyash Pile	3.1	2.5	2.9	2.8	17.0
FEO602WP1B	Active Flyash Pile	3.5	3.3	2.8	2.7	15.0
FEO603WP1B	Active Flyash Pile	2.4	2.3	1.1	1.4	5.5
FEO604WP1B	Active Flyash Pile	1.4	1.2	1.2	0.9	17.0
FEO605WP1B	Active Flyash Pile	1.9	1.7	2.2	2.2	12.0
FEO607WP1B	Active Flyash Pile	2.4	2.4	2.4	2.4	9.4
FEO608WP1B	Active Flyash Pile	2.1	1.8	2.2	2.1	8.4
FEO609WP1B	Active Flyash Pile	1.6	1.5	2.2	2.2	10.0

TABLE 4-76
(Continued)

		RCRA Metals		Organics						
Sample Number	Location	Ba mg/L	Cr mg/L	2-But mg/kg	Acet mg/kg	ChlF mg/kg	M Chl mg/kg	Tol mg/kg	1,1,1-Tri µg/kg	1,1-DiCl µg/kg
FEO601WP3B	Active Flyash Pile				63		160		140	
FEO602WP3B	Active Flyash Pile				140		200		420	
FEO603WP3B	Active Flyash Pile			67	37 B	11				
FEO604WP3B	Inactive Flyash Pile				24 B		110			
FEO605WP3B	Inactive Flyash Pile						52	50		
FEO607WP3B	Inactive Flyash Pile				50 B		21 B			
FEO608WP3B	Inactive Flyash Pile						28 B		100	
FEO609WP3B	Inactive Flyash Pile						27	34	84	
FE10111S1B	Test Pit 14 @ 2 ft.	0.53 B		NS	NS	NS	NS	NS		
FE10111S2B	Test Pit 14 @ 5 ft.	0.60 B		NS	NS	NS	NS	NS		
FE10121S1B	Test Pit 15 @ 1 ft.	0.25 B		NS	NS	NS	NS	NS		
FE10121S2B	Test Pit 15 @ 5 ft.	0.65 B		NS	NS	NS	NS	NS		
FE10121S3B	Test Pit 15 @ 10 ft.				22 B	6 B	12			
FE10131S1B	Test Pit 16 @ 1 ft.	0.70 B	0.05	NS	NS	NS	NS	NS		
FE10131S2B	Test Pit 16 @ 3 ft.	0.43 B		22	NS	NS	NS	NS		
FE10141S1B	Test Pit 17 @ 2 ft.	0.54 B		NS	NS	NS	NS	NS		
FE10141S2B	Test Pit 17 @ 4.5 ft.	0.49 B		NS	NS	NS	NS	NS		

Footnotes and Flags
B = analyte was found in the blank as well as the sample.

NS = sample not analyzed for indicated analyte.
Blank spaces indicate concentration below MDL.

Key to Organics Abbreviations
2-But--2-Butanone; Acet--Acetone; ChlF--Chloroform; M Chl--Methylene Chloride; Tol--Toluene; 1,1,1-Tri--Trichloroethane; 1,1-DiCl--1,1-Dichloroethane.

TABLE 4-76
(Continued)

Sample Number	Location	Radionuclides							
		U-235 pCi/g	U-238 pCi/g	Bi-214 pCi/g	Cs-137 pCi/g	Ra-226 pCi/g	Th-228 pCi/g	Th-232 pCi/g	Total U mg/kg
FE10111S1B	Test Pit 14 @ 2 ft.	0.83	46.0	3.20		3.60	1.1	1.2	71.0
FE10111S2B	Test Pit 14 @ 5 ft.	0.14		1.00		0.94	1.0	1.4	2.1
FE10121S1B	Test Pit 15 @ 1 ft.	0.16		1.10		1.10	1.6	1.5	15.0
FE10121S2B	Test Pit 15 @ 5 ft.	0.30	20.0	1.20		1.30	2.4	2.5	56.0
FE10131S1B	Test Pit 16 @ 1 ft.	0.63	49.0	1.10		1.10	1.2	0.8	85.0
FE10131S2B	Test Pit 16 @ 3 ft.	0.07		1.40		1.40	1.4	1.3	2.9
FE10141S1B	Test Pit 17 @ 2 ft.	0.19	12.0	1.70		1.70	1.1	1.3	14.0
FE10141S2B	Test Pit 17 @ 4.5 ft.	0.15	9.0	1.50		1.40	0.9	0.9	12.0

Footnotes

Blank space indicates concentration below MDL.

TABLE 4-77
ANALYTE CONCENTRATIONS WHICH EXCEED MINIMUM DETECTION LIMITS
SUBSURFACE SOIL SAMPLES (DOE, 1988)

		Radionuclides								RCRA Metals	
Sample Number	Location	U-235 pCi/g	U-238 pCi/g	Bi-214 pCi/g	Cs-137 pCi/g	Ra-226 pCi/g	Th-228 pCi/g	Th-232 pCi/g	Total U pCi/g	Ba mg/L	Cr mg/L
FEO1331S2B	Old Inciner. Area	12.00	773.0	1.20	0.30	1.30	2.60	2.20	1790.0	0.47	
FEO1341S1B	Old Inciner. Area	NS	NS	NS	NS	NS	NS	NS	196.0	0.27	
FEO1351S2B	Old Inciner. Area	1.50	96.0	2.80	0.14	3.00	1.50	1.40	355.0	0.53	
FEO1361S2B	Old Inciner. Area	34.00	2399.0	1.20		1.40	2.60	2.40	12400.0	0.63	0.03
FEO610DS2B	Fire Train. Area			0.36		0.38	0.52	0.61	26.0	0.60	
FEO611DS2B	Fire Train. Area			0.88		0.82	0.91	0.86	3.0	0.55	
FEO612DS2B	Fire Train. Area			0.32		0.41	0.54	0.51	5.8	0.66	
FE10011S2B	Test Pit 1 @ 0.9 ft.			0.86		0.73	1.20	1.30	3.8	0.33	
FE10011S3B	Test Pit 1 @ 3.9 ft.	0.07		0.99		0.98	1.10	1.10	1.9	0.23	
FE10021S1B	Test Pit 2 @ 1 ft.	0.07		0.78		0.82	0.65	0.68	2.0	0.47	
FE10021S2B	Test Pit 2 @ 3 ft.	0.10		0.93		1.10	1.50	1.30	1.8	0.47	
FE10031S1B	Test Pit 4 @ 1 ft.	0.07		1.10		1.00	1.10	1.10	4.3	0.41	

Footnotes

Blank space indicates concentration below MDL.
NS = sample not analyzed for indicated analyte.

TABLE 4-77
(Continued)

Sample Number	Location	Organics						
		Acet µg/kg	ChlF µg/kg	M Chl µg/kg	T-1,2-DCl µg/kg	1,1,1-Tri µg/kg	1,1 DiCl µg/kg	Tol µg/kg
FEO1331S3B	Old Inciner. Area	16 B	9	12 B				
FEO1341S3B	Old Inciner. Area	12 B	6	10 B				
FEO1351S3B	Old Inciner. Area	11 B	6					
FEO1361S3B	Old Inciner. Area	14 B		6 B				
FEO610DS3B	Fire Train. Area	24 B	7	80	8	52	55	8
FEO611DS3B	Fire Train. Area	55 B	5	31 B		2700	160	1700
FEO612DS3B	Fire Train. Area			40 B	180	7200	1600	990
FE10081S2B	Test Pit, 10			7 B				
FE10091S5B	Test Pit, 11	26 B	6	16 B				
FE10101S2B	Test Pit, 12	18 B	5 B	10 B				
FE10101S5B	Test Pit, 12	30 B	8 B	19 B				

Footnotes and Flags

Blank spaces indicate concentration below MDL.
B = analyte was found in the blank as well as the sample.

Key to Organics Abbreviations

Acet--Acetone; ChlF--Chloroform; M Chl--Methylene Chloride; 1,1-Tri--Trichloroethane; Tol--Toluene; T-1,2-DCl--Trans-1,2-Dichloroethene; 1,1-DiCl--1,1-Dichloroethane.

TABLE 4-77
(Continued)

Sample Number	Location	Radionuclides								RCRA Metals	
		U-235 pCi/g	U-238 pCi/g	Bi-214 pCi/g	Cs-137 pCi/g	Ra-226 pCi/g	Th-228 pCi/g	Th-232 pCi/g	Total U pCi/g	Ba mg/L	Cr mg/L
FE10031S2B	Test Pit 4 @ 3 ft.	0.06		0.99		1.00	1.10	1.10	1.8	0.66	
FE10041S1B	Test Pit 3 @ 1 ft.	0.12		1.00		1.20	1.20	1.10	10.0	0.37	
FE10041S2B	Test Pit 3 @ 3 ft.	0.09		1.00		1.00	1.10	1.10	1.8	0.64	0.04
FE10051S1B	Test Pit 6 @ 0.5 ft.	0.18		0.79		0.91	0.77	0.91	21.0	0.56	0.04
FE10051S2B	Test Pit 6 @ 3 ft.	0.07		1.20		1.10	1.00	1.10	1.8	0.28	
FE10061S1B	Test Pit 7 @ 0.8 ft.	0.12		0.93		0.96	0.98	0.87	12.0	0.70	
FE10061S2B	Test Pit 7 @ 3 ft.			0.77		0.89	0.72	0.67	2.0	0.66	0.03
FE10151S1B	Test Pit 8 @ 2 ft.	0.72	99.0	0.78	0.14	0.79	0.97	0.72	228*	0.54	
FE10151S2B	Test Pit 8 @ 6.5 ft.	0.41	64.0	0.93		0.90	0.97	0.94	250*	0.86	
FE10071S2B	Test Pit 9 @ 1 ft.									0.06	
FE10071S3B	Test Pit 9	0.09		1.1		1.1	1.4	1.4	1.6*	0.40	
FE10071S4B	Test Pit 9	0.11		1.1		1.2	1.1	0.9	14.0*	0.51	0.05
FE10081S1B	Test Pit 10 @ 0.5 ft.	0.43	24.0	1.30		1.10	13.00	11.00	35.0	0.95	0.04
FE10091S2B	Test Pit 11 @ 1 ft.	0.07		1.20		1.20	1.20	1.10	2.4	0.40	
FE10091S1B	Test Pit 11 @ 4.1 ft.								1.7	0.18	
FE10101S1B	Test Pit 12 @ 2 ft.	0.09		1.10		1.00	0.63	0.86	9.1	0.91	0.04
FE10101S2B	Test Pit 12 @ 4 ft.								2.9	0.34	

Footnotes

Blank space indicates concentration below MDL.
*Total U units are mg/kg.

TABLE 4-78
RADIONUCLIDES DETECTED DURING RI/FS SUBSURFACE SOIL SAMPLING

Radionuclide	Parameter	K-65 Berms	K-65 Slant Borings
Cs-137	Frequency of Detection	1/8	ND[a]
	Range (pCi/g)	0.230-0.230	ND
	Mean[b] (pCi/g)	0.116	ND
Pa-231	Frequency of Detection	1/19	ND
	Range (pCi/g)	25.300-25.300	ND
	Mean[a] (pCi/g)	0.988	ND
Pb-210	Frequency of Detection	17/17	2/2
	Range (pCi/g)	0.620-417.00	0.520-0.710
	Mean[a] (pCi/g)	26.228	[a]
Ra-224	Frequency of Detection	13/13	2/2
	Range (pCi/g)	0.550-1.680	0.770-0.910
	Mean[a] (pCi/g)	1.031	[b]
Ra-226	Frequency of Detection	19/19	10/10
	Range (pCi/g)	0.620-876.00	0.370-1.740
	Mean[a] (pCi/g)	48.476	0.871
Ra-228	Frequency of Detection	18/19	6/10
	Range (pCi/g)	0.530-1.320	0.700-1.240
	Mean[a] (pCi/g)	0.931	0.654
Sr-90	Frequency of Detection	ND	1/8
	Range (pCi/g)	ND	0.816-0.816
	Mean[a] (pCi/g)	ND	0.321
Th-228	Frequency of Detection	17/17	9/10
	Range (pCi/g)	1.110-14.900	0.820-1.910
	Mean[a] (pCi/g)	2.202	1.210

See footnotes at end of table.

Table 4-78
(Continued)

Radionuclide	Parameter	K-65 Berms	K-65 Slant Borings
Th-230	Frequency of Detection	17/17	7/10
	Range (pCi/g)	0.900-51.200	0.930-2.590
	Mean[a] (pCi/g)	4.848	1.001
Th-232	Frequency of Detection	15/17	7/10
	Range (pCi/g)	0.700-1.450	0.620-1.000
	Mean[a] (pCi/g)	0.871	0.673
U-234	Frequency of Detection	17/17	10/10
	Range (pCi/g)	0.810-24.200	0.610-12.400
	Mean[a] (pCi/g)	2.934	3.517
U-235/236	Frequency of Detection	1/17	1/10
	Range (pCi/g)	1.310-1.310	0.620-0.620
	Mean[a] (pCi/g)	0.359	0.323
U-238	Frequency of Detection	17/17	10/10
	Range (pCi/g)	0.750-24.700	0.600-13.300
	Mean[a] (pCi/g)	3.148	3.757

		Plant 2/3	Plant 6	Plant 9	Pilot Plant	Berm of Waste Pit 1	Berm of Waste Pit 3	Active Flyash Pile	Inactive Flyash Pile
Cs-137	Frequency of Detection	6/35	ND	2/34	6/20				
	Range (pCi/g)	0.200-0.480	ND	0.242-0.469	0.302-13.800	ND	ND	ND	ND
	Mean[a] (pCi/g)	0.135	ND	0.115	0.219	ND	ND	ND	ND
Np-237	Frequency of Detection	2/34	ND	1/10	ND	ND	ND	ND	ND
	Range (pCi/g)	0.970-2.630	ND	0.710-0.710	ND	ND	ND	ND	ND
	Mean[a] (pCi/g)	0.543	ND	0.341	ND	ND	ND	ND	ND

See footnotes at end of table.

Table 4-78
(Continued)

		Plant 2/3	Plant 6	Plant 9	Pilot Plant	Berm of Waste Pit 1	Berm of Waste Pit 3	Active Flyash Pile	Inactive Flyash Pile
Pu-238	Frequency of Detection	2/35	5/68	ND	2/20	ND	ND	ND	ND
	Range (pCi/g)	0.718-0.755	0.852-158.00	ND	6.100-19.800	ND	ND	ND	ND
	Mean[a] (pCi/g)	0.325	0.369	ND	0.430	ND	ND	ND	ND
Pu-239/240	Frequency of Detection	3/35	1/68	ND	1/20	ND	1/13	ND	ND
	Range (pCi/g)	0.713-0.926	1.410-1.410	ND	1.650-1.650	ND	0.800-0.800	ND	ND
	Mean[a] (pCi/g)	0.346	0.335	ND	0.367	ND	0.338	ND	ND
Ra-226	Frequency of Detection	34/35	57/68	32/34	20/20	2/2	13/13	9/9	4/4
	Range (pCi/g)	0.400-26.500	0.370-1.430	0.478-1.130	0.500-32.100	117.00-1180.0	0.400-19.700	0.760-6.220	1.390-3.070
	Mean[a] (pCi/g)	2.957	0.752	0.739	5.258	[b]	3.631	3.373	2.210
Ra-228	Frequency of Detection	28/35	40/68	26/34	18/20	2/2	11/13	9/9	4/4
	Range (pCi/g)	0.677-2.300	0.320-1.490	0.480-27.900	0.710-170.00	34.200-165.00	0.600-18.600	0.560-5.320	1.030-3.130
	Mean[a] (pCi/g)	1.070	0.669	1.479	15.558	[b]	3.323	2.698	1.715
Sr-90	Frequency of Detection	8/35	23/68	4/10	4/20	2/2	2/13	9/9	2/4
	Range (pCi/g)	0.660-6.900	0.510-47.600	0.682-2.540	0.650-1.070	2.400-8.900	1.300-1.500	0.700-3.610	1.230-1.250
	Mean[a] (pCi/g)	0.752	0.495	0.467	0.409	[b]	0.326	1.439	0.833
Tc-99	Frequency of Detection	13/35	18/68	3/10	8/20	ND	4/13	ND	ND
	Range (pCi/g)	0.800-3.000	0.999-210.00	1.250-10.900	1.240-55.300	ND	1.200-6.900	ND	ND
	Mean[a] (pCi/g)	0.937	0.838	0.784	1.372	ND	0.803	ND	ND
Th-228	Frequency of Detection	24/32	45/68	15/18	19/24	2/2	12/13	9/9	4/4
	Range (pCi/g)	0.655-2.850	0.656-22.100	0.644-5.220	0.600-26.100	94.000-581.00	0.700-22.900	1.160-5.790	1.110-3.140
	Mean[a] (pCi/g)	1.069	1.372	1.144	2.957	[b]	3.131	3.154	2.135

See footnotes at end of table.

Table 4-78
(Continued)

		Plant 2/3	Plant 6	Plant 9	Pilot Plant	Berm of Waste Pit 1	Berm of Waste Pit 3	Active Flyash Pile	Inactive Flyash Pile
Th-230	Frequency of Detection	37/44	52/68	19/20	23/25	2/2	13/13	9/9	4/4
	Range (pCi/g)	0.600-127.00	0.634-9.730	0.850-82.100	0.610-55.600	24.100-7597.0	1.100-710.00	0.850-6.080	1.730-2.980
	Mean[a] (pCi/g)	12.997	1.803	5.349	4.928	[b]	61.969	3.063	2.534
Th-232	Frequency of Detection	33/44	36/68	17/20	14/25	2/2	12/13	9/9	4/4
	Range (pCi/g)	0.607-3.070	0.625-2.760	0.606-84.900	0.350-20.400	93.200-761.00	0.700-33.100	0.520-5.080	0.950-2.420
	Mean[a] (pCi/g)	1.033	0.783	5.026	1.901	[b]	3.846	2.211	1.588
U-234	Frequency of Detection	34/35	66/67	10/10	18/18	2/2	12/13	9/9	3/3
	Range (pCi/g)	0.700-2039.0	0.610-18093	1.110-118.00	1.050-290.00	269.00-429.00	0.600-238.00	0.932-5.700	2.880-20.640
	Mean[a] (pCi/g)	350.09	304.03	58.686	99.058	[b]	47.746	3.404	6.009
U-235/236	Frequency of Detection	29/35	32/67	8/10	16/18	2/2	5/13	ND	1/3
	Range (pCi/g)	1.010-398.00	0.620-1021.0	1.980-36.200	1.640-17.300	17.600-144.00	1.900-13.200	ND	0.687-0.687
	Mean[a] (pCi/g)	23.842	1.469	9.617	6.012	[b]	0.933	ND	0.429
U-238	Frequency of Detection	35/35	66/67	10/10	18/18	2/2	12/13	9/9	3/3
	Range (pCi/g)	0.600-2014.0	0.600-19067	1.090-115.00	1.160-270.00	384.00-1404.0	0.600-227.00	1.050-7.960	297.0-21.940
	Mean[a] (pCi/g)	345.79	351.40	52.080	92.571	[b]	46.562	4.363	6.356

[a]If number of detects <7 or frequency of detection <50%, a geometric mean is given, otherwise, an arithmetic mean is given.
[b]Not applicable if sample size ≤2.
[c]ND, not detected.

See footnotes at end of table.

TABLE 4-79A
INORGANIC CHEMICALS DETECTED DURING RI/FS SAMPLING OF SUBSURFACE SOILS

Inorganic Chemical		K-65 Berms	Waste Pit 1	Burn Pit	Active Flyash Pile	Inactive Flyash Pile	Solid Waste Landfill
Aluminum	Frequency of Detection	9/9	--[a]	1/1	8/8	7/7	2/2
	Range (mg/kg)	4530.0-12100	--	8550.0-8550.0	2860.0-17900	3690.0-9550.0	6400.0-8420.0
	Mean[b] (mg/kg)	9510.0	--	[c]	6166.3	6731.4	[b]
Antimony	Frequency of Detection	8/8	ND	1/1	2/8	3/7	ND
	Range (mg/kg)	18.000-27.400	ND	13.400-13.400	9.000-31.100	8.800-16.300	ND
	Mean[b] (mg/kg)	22.325	ND	[b]	5.478	6.256	ND
Arsenic	Frequency of Detection	9/9	ND	1/1	8/8	7/7	2/2
	Range (mg/kg)	3.600-8.300	ND	6.900-6.900	8.400-66.500	1.700-35.400	3.300-6.100
	Mean[b] (mg/kg)	6.233	ND	[b]	36.900	16.886	[b]
Barium	Frequency of Detection	9/9	ND	1/1	8/8	7/7	2/2
	Range (mg/kg)	30.500-97.300	ND	295.00-295.00	31.200-508.00	89.600-637.00	37.300-90.200
	Mean[b] (mg/kg)	69.278	ND	[b]	185.85	311.51	[b]
Beryllium	Frequency of Detection	8/8	ND	1/1	8/8	7/7	2/2
	Range (mg/kg)	0.670-1.100	ND	1.500-1.500	0.740-4.600	0.600-6.700	0.590-0.630
	Mean[b] (mg/kg)	0.835	ND	[b]	2.424	2.489	[b]
Cadmium	Frequency of Detection	9/9	ND	1/1	2/8	6/7	2/2
	Range (mg/kg)	2.500-7.500	ND	5.400-5.400	1.300-5.200	0.660-2.000	2.300-2.700
	Mean[b] (mg/kg)	4.244	ND	[b]	0.453	0.934	[b]
Calcium	Frequency of Detection	9/9	ND	1/1	8/8	7/7	2/2
	Range (mg/kg)	11600-161000	ND	88900-88900	1790.0-155000	2510.0-36800	79500-113000
	Mean[b] (mg/kg)	63567	ND	[b]	24564	11906	[b]
Chromium	Frequency of Detection	9/9	ND	1/1	8/8	7/7	2/2
	Range (mg/kg)	15.700-28.400	ND	67.000-67.000	7.200-26.800	6.500-19.600	22.500-23.400
	Mean[b] (mg/kg)	19.133	ND	[b]	16.213	12.914	[b]

TABLE 4-79A
(Continued)

Inorganic Chemical		K-65 Berms	Waste Pit 1	Burn Pit	Active Flyash Pile	Inactive Flyash Pile	Solid Waste Landfill
Cobalt	Frequency of Detection	8/9	ND	1/1	8/8	7/7	2/2
	Range (mg/kg)	10.500-14.900	ND	39.900-39.900	5.000-18.800	5.700-11.200	7.500-12.700
	Mean[b] (mg/kg)	11.489	ND	[b]	12.450	8.286	[b]
Copper	Frequency of Detection	9/9	ND	1/1	8/8	7/7	2/2
	Range (mg/kg)	19.300-27.000	ND	259.00-259.00	19.100-66.100	14.600-44.900	18.600-22.200
	Mean[b] (mg/kg)	21.922	ND	[b]	42.575	27.871	[b]
Cyanide	Frequency of Detection	4/9	ND	ND	5/10	8/9	2/2
	Range (mg/kg)	0.120-1.600	ND	ND	0.170-0.690	0.123-1.200	0.500-0.790
	Mean[b] (mg/kg)	0.143	ND	ND	0.163	0.485	[b]
Iron	Frequency of Detection	9/9	ND	1/1	8/8	7/7	2/2
	Range (mg/kg)	11200-27500	ND	31200-31200	2710.0-31100	5510.0-16300	16000-22200
	Mean[b] (mg/kg)	21478	ND	[b]	10544	10374	[b]
Lead	Frequency of Detection	9/9	ND	1/1	8/8	7/7	2/2
	Range (mg/kg)	6.100-12.200	ND	279.00-279.00	7.900-61.700	7.000-67.100	10.100-147.00
	Mean[b] (mg/kg)	10.411	ND	[b]	31.363	25.314	[b]
Magnesium	Frequency of Detection	9/9	ND	1/1	8/8	7/7	2/2
	Range (mg/kg)	5070.0-40700	ND	24600-24600	341.00-35500	377.00-10100	27900-29600
	Mean[b] (mg/kg)	17884	ND	[b]	6447.4	3317.0	[b]
Manganese	Frequency of Detection	9/9	ND	1/1	8/8	7/7	2/2
	Range (mg/kg)	228.00-880.00	ND	677.00-677.00	16.000-523.00	41.800-736.00	375.00-826.00
	Mean[b] (mg/kg)	497.33	ND	[b]	183.14	265.54	[b]

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TABLE 4-79A
(Continued)

Inorganic Chemical		K-65 Berms	Waste Pit 1	Burn Pit	Active Flyash Pile	Inactive Flyash Pile	Solid Waste Landfill
Mercury	Frequency of Detection	ND	ND	1/1	1/8	2/7	ND
	Range (mg/kg)	ND	ND	1.200-1.200	0.160-0.160	0.180-0.440	ND
	Mean[b] (mg/kg)	ND	ND	[b]	0.074	0.098	ND
Molybdenum	Frequency of Detection	8/9	ND	1/1	8/8	7/7	2/2
	Range (mg/kg)	2.400-13.300	ND	19.300-19.300	7.900-18.800	3.200-9.400	10.200-11.200
	Mean[b] (mg/kg)	4.678	ND	[b]	12.713	6.043	[b]
Nickel	Frequency of Detection	9/9	ND	1/1	8/8	7/7	2/2
	Range (mg/kg)	21.700-33.700	ND	83.700-83.700	9.800-45.700	9.700-19.600	22.700-30.200
	Mean[b] (mg/kg)	27.900	ND	[b]	27.038	15.514	[b]
Potassium	Frequency of Detection	9/9	ND	1/1	8/8	7/7	2/2
	Range (mg/kg)	546.00-1230.0	ND	1250.0-1250.0	453.00-1230.0	456.00-1430.0	960.00-1230.0
	Mean[b] (mg/kg)	924.33	ND	[b]	880.63	945.29	[b]
Selenium	Frequency of Detection	ND	ND	1/1	6/8	6/7	ND
	Range (mg/kg)	ND	ND	0.660-0.660	1.600-10.200	0.730-2.900	ND
	Mean[b] (mg/kg)	ND	ND	[b]	1.714	1.368	ND
Silver	Frequency of Detection	9/9	ND	1/1	2/8	3/7	2/2
	Range (mg/kg)	3.600-19.200	ND	20.400-20.400	6.600-18.500	4.400-8.300	10.200-12.500
	Mean[b] (mg/kg)	8.789	ND	[b]	2.162	2.555	[b]
Sodium	Frequency of Detection	9/9	ND	1/1	8/8	7/7	2/2
	Range (mg/kg)	47.800-237.00	ND	495.00-495.00	109.00-312.00	71.900-294.00	126.00-342.00
	Mean[b] (mg/kg)	117.23	ND	[b]	189.25	170.41	[b]
Thallium	Frequency of Detection	3/9	ND	ND	5/8	ND	ND
	Range (mg/kg)	0.630-0.970	ND	ND	0.960-2.100	ND	ND
	Mean[b] (mg/kg)	0.413	ND	ND	1.193	ND	ND
Vanadium	Frequency of Detection	9/9	ND	1/1	8/8	7/7	2/2

TABLE 4-79A
(Continued)

Inorganic Chemical		K-65 Berms	Waste Pit 1	Burn Pit	Active Flyash Pile	Inactive Flyash Pile	Solid Waste Landfill
	Range (mg/kg)	21.800-28.400	ND	36.700-36.700	22.900-40.300	17.800-33.500	22.200-26.100
	Mean[b] (mg/kg)	26.067	ND	[b]	31.563	26.000	[b]
Zinc	Frequency of Detection	9/9	ND	1/1	8/8	7/7	2/2
	Range (mg/kg)	30.700-61.000	ND	505.00-505.00	18.900-117.00	10.500-102.00	36.400-46.900
	Mean[b] (mg/kg)	50.356	ND	[b]	59.663	31.800	[b]

Inorganics		Plant 2/3	Plant 6	Plant 9	Pilot Plant
Aluminum	Frequency of Detection	3/3	9/9	1/1	12/12
	Range (mg/kg)	4740.0-14100	1520.0-14600	2810.0-2810.0	9.530-12400
	Mean[b] (mg/kg)	9013.3	6284.4	[b]	
Antimony	Frequency of Detection	ND	7/9	1/1	4/12
	Range (mg/kg)	ND	13.000-21.400	19.200-19.200	13.800-29.800
	Mean[b] (mg/kg)	ND	14.406	[b]	1.812
Arsenic	Frequency of Detection	3/3	9/9	1/1	12/12
	Range (mg/kg)	5.900-26.500	2.000-4.600	5.400-5.400	2.200-10.200
	Mean[b] (mg/kg)	10.951	2.933	[b]	5.408
Barium	Frequency of Detection	3/3	9/9	1/1	12/12
	Range (mg/kg)	63.000-78.900	12.300-130.00	21.600-21.600	0.089-3610.0
	Mean[b] (mg/kg)	69.167	58.000	[b]	472.13
Beryllium	Frequency of Detection	3/3	9/9	1/1	11/12
	Range (mg/kg)	1.000-2.400	0.290-0.980	0.570-0.570	0.002-1.200
	Mean[b] (mg/kg)	1.700	0.614	[b]	0.707

TABLE 4-79A
(Continued)

Inorganics		Plant 2/3	Plant 6	Plant 9	Pilot Plant
Cadmium	Frequency of Detection	3/3	8/9	1/1	12/12
	Range (mg/kg)	4.100-6.900	0.920-7.000	6.300-6.300	0.003-5.900
	Mean[b] (mg/kg)	5.400	3.928	[b]	3.442
Calcium	Frequency of Detection	3/3	9/9	1/1	12/12
	Range (mg/kg)	48200-115000	4630.0-142000	112000-112000	35.200-181000
	Mean[b] (mg/kg)	83492	64770	[b]	67157
Chromium	Frequency of Detection	3/3	9/9	1/1	12/12
	Range (mg/kg)	30.500-75.500	4.700-18.900	11.400-11.400	0.023-24.400
	Mean[b] (mg/kg)	44.122	11.800	[b]	14.804
Cobalt	Frequency of Detection	3/3	9/9	1/1	12/12
	Range (mg/kg)	12.800-17.400	5.900-13.300	7.100-7.100	0.014-14.000
	Mean[b] (mg/kg)	14.833	8.744	[b]	9.128
Copper	Frequency of Detection	3/3	9/9	1/1	12/12
	Range (mg/kg)	16.800-38.500	7.600-26.500	15.100-15.100	0.022-28.900
	Mean[b] (mg/kg)	23.514	16.167	[b]	14.746
Cyanide	Frequency of Detection	ND	3/9	ND	ND
	Range (mg/kg)	ND	0.150-0.650	ND	ND
	Mean[b] (mg/kg)	ND	0.279	ND	ND
Iron	Frequency of Detection	3/3	9/9	1/1	12/12
	Range (mg/kg)	8880.0-23300	4680.0-23400	7780.0-7780.0	18.100-30100
	Mean[b] (mg/kg)	17127	11037	[b]	15585
Lead	Frequency of Detection	3/3	9/9	1/1	11/11
	Range (mg/kg)	161.00-440.00	2.900-31.800	7.100-7.100	7.700-117.00
	Mean[b] (mg/kg)	311.67	10.978	[b]	25.136
Magnesium	Frequency of Detection	3/3	9/9	1/1	12/12

TABLE 4-79A
(Continued)

Inorganics		Plant 2/3	Plant 6	Plant 9	Pilot Plant
	Range (mg/kg)	17500-38.600	3670.0-39700	39200-39200	9.740-27900
	Mean[b] (mg/kg)	25833	19499	[b]	13677
Manganese	Frequency of Detection	3/3	9/9	1/1	11/12
	Range (mg/kg)	293.00-465.00	188.00-892.00	262.00-262.00	0.614-1500.0
	Mean[b] (mg/kg)	382.00	307.22	[b]	395.47
Mercury	Frequency of Detection	2/3	2/9	ND	8/12
	Range (mg/kg)	0.730-1.300	0.050-0.070	ND	0.220-1.100
	Mean[b] (mg/kg)	0.693	0.057	ND	0.308
Molybdenum	Frequency of Detection	1/3	6/9	1/1	3/12
	Range (mg/kg)	2.900-2.900	3.500-4.500	3.800-3.800	2.600-3.300
	Mean[b] (mg/kg)	1.650	2.928	[b]	1.350
Nickel	Frequency of Detection	3/3	9/9	1/1	12/12
	Range (mg/kg)	38.000-50.000	17.000-26.600	20.100-20.100	0.040-40.500
	Meana[a] (mg/kg)	43.433	20.222	[b]	23.432
Potassium	Frequency of Detection	3/3	9/9	1/1	12/12
	Range (mg/kg)	856.00-1960.0	204.00-943.00	490.00-490.00	571.00-2470.0
	Mean[b] (mg/kg)	1170.6	521.33	[b]	1103.7
Silver	Frequency of Detection	3/3	6/9	1/1	8/12
	Range (mg/kg)	3.900-17.200	1.300-7.800	6.900-6.900	0.003-8.900
	Mean[b] (mg/kg)	7.342	3.943	[b]	2.829
Sodium	Frequency of Detection	3/3	9/9	1/1	12/12
	Range (mg/kg)	155.00-160.00	80.200-171.00	142.00-142.00	0.150-2220.0
	Mean[b] (mg/kg)	158.33	113.14	[b]	933.63
Thallium	Frequency of Detection	ND	1/9	ND	5/12
	Range (mg/kg)	ND	0.570-0.570	ND	0.260-0.460

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TABLE 4-79A
(Continued)

Inorganics		Plant 2/3	Plant 6	Plant 9	Pilot Plant
	Mean[b] (mg/kg)	ND	0.238	ND	0.265
Vanadium	Frequency of Detection	3/3	9/9	1/1	12/12
	Range (mg/kg)	24.500-35.600	4.700-32.300	13.200-13.200	0.027-29.400
	Mean[b] (mg/kg)	30.400	15.344	[b]	17.621
Zinc	Frequency of Detection	3/3	9/9	1/1	12/12
	Range (mg/kg)	65.500-247.00	17.300-82.100	30.100-30.100	0.043-242.00
	Mean[b] (mg/kg)	112.92	46.900	[b]	122.29

[a]If number of detects <7 or frequency of detection <50%, a geometric mean is given, otherwise, an arithmetic mean is given.
[b]Not applicable if sample size ≤ 2.
[c]Not detected.

TABLE 4-79B
ORGANIC CHEMICALS DETECTED DURING RI/FS SAMPLING OF SUBSURFACE SOILS

Organic Chemical		K-65 Berms	Waste Pit 1	Burn Pit	Active Flyash Pile	Inactive Flyash Pile	Solid Waste Landfill
1,1,1-tri-chloroethane	Frequency of Detection	ND[a]	2/4	1/3	4/11	3/7	ND
	Range (mg/kg)	ND	0.006-0.120	0.002-0.002	0.025-1.300	0.004-0.096	ND
	Mean[a] (mg/kg)	ND	0.008	0.003	0.010	0.008	ND
1,1-di-chloroethane	Frequency of Detection	ND	ND	1/3	ND	ND	1/2
	Range (mg/kg)	ND	ND	0.110-0.110	ND	ND	0.130-0.130
	Mean[a] (mg/kg)	ND	ND	0.012	ND	ND	[b]
1,1-di-chloroethene	Frequency of Detection	ND	ND	ND	1/11	ND	ND
	Range (mg/kg)	ND	ND	ND	0.002-0.002	ND	ND
	Mean[a] (mg/kg)	ND	ND	ND	0.003	ND	ND
2-butanone	Frequency of Detection	4/10	1/4	3/3	2/11	1/7	1/2
	Range (mg/kg)	0.004-0.011	0.017-0.017	0.003-0.041	0.003-0.004	0.029-0.029	0.003-0.003
	Mean[a] (mg/kg)	0.006	0.008	0.019	0.006	0.008	[b]
2-chlorophenol	Frequency of Detection	ND	ND	ND	1/8	ND	ND
	Range (mg/kg)	ND	ND	ND	0.048-0.048	ND	ND
	Mean[a] (mg/kg)	ND	ND	ND	0.195	ND	ND
2-hexanone	Frequency of Detection	1/10	1/4	1/3	ND	ND	ND
	Range (mg/kg)	0.002-0.002	0.010-0.010	0.002-0.002	ND	ND	ND
	Mean[a] (mg/kg)	0.005	0.007	0.005	ND	ND	ND
2-methylnaphthalene	Frequency of Detection	ND	ND	ND	1/8	ND	ND
	Range (mg/kg)	ND	ND	ND	0.160-0.160	ND	ND
	Mean[a] (mg/kg)	ND	ND	ND	0.210	ND	ND
4-chloro-3-methyl phenol	Frequency of Detection	ND	ND	ND	1/8	ND	ND
	Range (mg/kg)	ND	ND	ND	0.058-0.058	ND	ND
	Mean[a] (mg/kg)	ND	ND	ND	0.197	ND	ND

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TABLE 4-79B
(Continued)

Organic Chemical		K-65 Berms	Waste Pit 1	Burn Pit	Active Flyash Pile	Inactive Flyash Pile	Solid Waste Landfill
4-methyl-2-pentanone	Frequency of Detection	1/10	1/4	1/3	1/11	1/7	ND
	Range (mg/kg)	0.004-0.004	0.005-0.005	0.006-0.006	0.011-0.011	0.002-0.002	ND
	Mean[a] (mg/kg)	0.006	0.005	0.007	0.006	0.006	ND
4-nitro-phenol	Frequency of Detection	ND	ND	ND	1/1	ND	ND
	Range (mg/kg)	ND	ND	ND	0.048-0.048	ND	ND
	Mean[a] (mg/kg)	ND	ND	ND	[b]	ND	ND
Acetone	Frequency of Detection	9/10	3/4	3/3	8/11	5/7	2/2
	Range (mg/kg)	0.011-0.064	0.005-0.024	0.023-0.100	0.002-0.019	0.009-0.190	0.010-0.026
	Mean[a] (mg/kg)	0.026	0.008	0.043	0.009	0.017	[b]
Aroclor-1254	Frequency of Detection	ND	ND	1/1	ND	1/1	ND
	Range (mg/kg)	ND	ND	2.300-2.300	ND	0.210-0.210	ND
	Mean[a] (mg/kg)	ND	ND	[b]	ND	[b]	ND
Benzo(b) fluoranthene	Frequency of Detection	ND	ND	ND	ND	1/5	ND
	Range (mg/kg)	ND	ND	ND	ND	0.093-0.093	ND
	Mean[a] (mg/kg)	ND	ND	ND	ND	0.202	ND
Benzoic Acid	Frequency of Detection	ND	ND	ND	2/8	2/7	ND
	Range (mg/kg)	ND	ND	ND	0.052-0.073	0.097-0.150	ND
	Mean[a] (mg/kg)	ND	ND	ND	0.809	1.085	ND
Bromodichloro-methane	Frequency of Detection	ND	ND	ND	1/11	ND	ND
	Range (mg/kg)	ND	ND	ND	0.002-0.002	ND	ND
	Mean[a] (mg/kg)	ND	ND	ND	0.003	ND	ND
Carbon disulfide	Frequency of Detection	1/10	ND	1/3	ND	1/7	ND
	Range (mg/kg)	0.006-0.006	ND	0.001-0.001	ND	0.003-0.003	ND
	Mean[a] (mg/kg)	0.003	ND	0.003	ND	0.003	ND

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TABLE 4-79B
(Continued)

Organic Chemical		K-65 Berms	Waste Pit 1	Burn Pit	Active Flyash Pile	Inactive Flyash Pile	Solid Waste Landfill
Carbon tetrachloride	Frequency of Detection	ND	1/4	ND	ND	ND	ND
	Range (mg/kg)	ND	0.002-0.002	ND	ND	ND	ND
	Mean[a] (mg/kg)	ND	0.003	ND	ND	ND	ND
Chlorobenzene	Frequency of Detection	ND	ND	1/3	ND	ND	ND
	Range (mg/kg)	ND	ND	0.002-0.002	ND	ND	ND
	Mean[a] (mg/kg)	ND	ND	0.003	ND	ND	ND
Chloroform	Frequency of Detection	1/10	3/4	ND	2/11	ND	ND
	Range (mg/kg)	0.004-0.004	0.002-0.330	ND	0.004-0.013	ND	ND
	Mean[a] (mg/kg)	0.003	0.011	ND	0.004	ND	ND
Di-n-butylphthalate	Frequency of Detection	1/7	ND	ND	ND	ND	ND
	Range (mg/kg)	0.048-0.048	ND	ND	ND	ND	ND
	Mean[a] (mg/kg)	0.178	ND	ND	ND	ND	ND
Di-n-octylphthalate	Frequency of Detection	2/7	ND	ND	ND	ND	ND
	Range (mg/kg)	0.082-0.097	ND	ND	ND	ND	ND
	Mean[a] (mg/kg)	0.169	ND	ND	ND	ND	ND
Diethyl-phthalate	Frequency of Detection	1/7	ND	ND	ND	ND	ND
	Range (mg/kg)	0.120-0.120	ND	ND	ND	ND	ND
	Mean[a] (mg/kg)	0.189	ND	ND	ND	ND	ND
Ethyl benzene	Frequency of Detection	ND	1/4	3/3	ND	ND	ND
	Range (mg/kg)	ND	0.003-0.003	0.006-0.028	ND	ND	ND
	Mean[a] (mg/kg)	ND	0.003	0.011	ND	ND	ND
Methylene chloride	Frequency of Detection	10/10	2/4	3/3	10/11	7/7	2/2
	Range (mg/kg)	0.002-0.022	0.005-0.024	0.006-0.028	0.001-0.073	0.004-0.020	0.004-0.005
	Mean[a] (mg/kg)	0.005	0.005	0.016	0.015	0.008	

TABLE 4-79B
(Continued)

Organic Chemical		K-65 Berms	Waste Pit 1	Burn Pit	Active Flyash Pile	Inactive Flyash Pile	Solid Waste Landfill
Naphthalene	Frequency of Detection	ND	ND	ND	1/8	ND	ND
	Range (mg/kg)	ND	ND	ND	0.082-0.082	ND	ND
	Mean[a] (mg/kg)	ND	ND	ND	0.200	ND	ND
Phenanthrene	Frequency of Detection	ND	ND	ND	2/8	ND	ND
	Range (mg/kg)	ND	ND	ND	0.048-0.072	ND	ND
	Mean[a] (mg/kg)	ND	ND	ND	0.179	ND	ND
Phenol	Frequency of Detection	3/7	ND	ND	1/8	3/7	ND
	Range (mg/kg)	0.110-0.200	ND	ND	0.058-0.058	0.180-0.310	ND
	Mean[a] (mg/kg)	0.187	ND	ND	0.197	0.315	ND
Tetrachloro-ethene	Frequency of Detection	2/10	2/4	ND	ND	ND	ND
	Range (mg/kg)	0.001-0.004	0.150-0.210	ND	ND	ND	ND
	Mean[a] (mg/kg)	0.003	0.021	ND	ND	ND	ND
Toluene	Frequency of Detection	8/10	2/4	3/3	1/11	1/7	2/2
	Range (mg/kg)	0.001-0.200	0.004-0.011	0.002-0.003	0.013-0.013	0.003-0.003	0.002-0.002
	Mean[a] (mg/kg)	0.026	0.005	0.002	0.004	0.003	[b]
Total organic carbon	Frequency of Detection		3/3	1/1	ND	ND	ND
	Range (mg/kg)		6881.0-33600	152000-152000	ND	ND	ND
	Mean[a] (mg/kg)		18548	[b]	ND	ND	ND
Total xylenes	Frequency of Detection	1/10	2/4	3/3	ND	ND	ND
	Range (mg/kg)	0.069-0.069	0.012-0.024	0.038-0.190	ND	ND	ND
	Mean[a] (mg/kg)	0.004	0.007	0.101	ND	ND	ND
Tricloroethene	Frequency of Detection	ND	2/4	ND	ND	ND	ND
	Range (mg/kg)	ND	0.400-0.027	ND	ND	ND	ND
	Mean (mg/kg)	ND	0.005	ND	ND	ND	ND

TABLE 4-79B
(Continued)

Organic Chemical		K-65 Berms	Waste Pit 1	Burn Pit	Active Flyash Pile	Inactive Flyash Pile	Solid Waste Landfill
Vinyl chloride	Frequency of Detection	ND	ND	1/3	ND	ND	ND
	Range (mg/kg)	ND	ND	0.003-0.003	ND	ND	ND
	Mean[a] (mg/kg)	ND	ND	[b]	ND	ND	ND
bis(2-ethylhexyl) phthalate	Frequency of Detection	1/7	ND	3/8	ND	ND	ND
	Range (mg/kg)	1.000-1.000	ND	0.042-2.700	ND	ND	ND
	Mean[a] (mg/kg)	0.314	ND	0.265	ND	ND	ND

Organic Chemical		Plant 2/3	Plant 6	Plant 9	Pilot Plant
1,1,1-trichloroethane	Frequency of Detection	1/6	1/12	3/26	1/10
	Range (mg/kg)	0.006-0.006	0.002-0.002	0.001-0.068	0.450-0.450
	Mean[a] (mg/kg)	0.003	0.003	0.005	0.008
1,1,2,2-tetrachloroethane	Frequency of Detection	ND	ND	ND	2/10
	Range (mg/kg)	ND	ND	ND	0.047-0.350
	Mean[a] (mg/kg)	ND	ND	ND	0.006
1,1,2-trichloroethane	Frequency of Detection	ND	ND	ND	1/10
	Range (mg/kg)	ND	ND	ND	0.002-0.002
	Mean[a] (mg/kg)	ND	ND	ND	0.083
1,1-dichloroethane	Frequency of Detection	2/6	ND	ND	1/10
	Range (mg/kg)	0.014-0.046	ND	ND	0.027-0.027
	Mean[a] (mg/kg)	0.006	ND	ND	0.085
1,1-dichloroethene	Frequency of Detection	1/6	3/12	1/26	2/9
	Range (mg/kg)	0.002-0.002	0.001-0.025	0.013-0.013	0.004-0.044
	Mean[a] (mg/kg)	0.004	0.005	0.003	0.004
1,2-dichloroethane	Frequency of Detection	ND	ND	ND	1/10

TABLE 4-79B
(Continued)

Organic Chemical		Plant 2/3	Plant 6	Plant 9	Pilot Plant
	Range (mg/kg)	ND	ND	ND	0.002-0.002
	Mean[a] (mg/kg)	ND	ND	ND	0.083
1,2-dichloroethylene	Frequency of Detection	ND	5/12	3/26	3/10
	Range (mg/kg)	ND	0.003-0.055	0.007-0.025	0.002-1.600
	Mean[a] (mg/kg)	ND	0.011	0.005	0.006
2-butanone	Frequency of Detection	5/6	10/12	16/26	8/10
	Range (mg/kg)	0.004-0.120	0.002-0.029	0.003-0.017	0.001-2.400
	Mean[a] (mg/kg)	0.015	0.008	0.006	0.251
2-hexanone	Frequency of Detection	ND	1/12	1/26	ND
	Range (mg/kg)	ND	0.003-0.003	0.001-0.001	ND
	Mean[a] (mg/kg)	ND	0.006	0.005	ND
4-methyl-2-pentanone	Frequency of Detection	1/5	2/12	3/26	2/10
	Range (mg/kg)	0.002-0.002	0.001-0.003	0.005-0.017	0.003-0.330
	Mean[a] (mg/kg)	0.005	0.006	0.006	0.008
Acenaphthene	Frequency of Detection	ND	ND	ND	3/12
	Range (mg/kg)	ND	ND	ND	0.110-1.600
	Mean[a] (mg/kg)	ND	ND	ND	0.322
Acetone	Frequency of Detection	6/6	12/12	23/26	7/10
	Range (mg/kg)	0.005-0.190	0.011-0.130	0.003-0.049	0.006-0.061
	Mean[a] (mg/kg)	0.026	0.047	0.012	0.186
Anthracene	Frequency of Detection	ND	ND	ND	4/12
	Range (mg/kg)	ND	ND	ND	0.060-2.800
	Mean[a] (mg/kg)	ND	ND	ND	0.244
Aroclor-1221	Frequency of Detection	ND	1/3	ND	ND
	Range (mg/kg)	ND	0.083-0.083	ND	ND

TABLE 4-79B
(Continued)

Organic Chemical		Plant 2/3	Plant 6	Plant 9	Pilot Plant
	Mean[a] (mg/kg)	ND	0.056	ND	ND
Aroclor-1254	Frequency of Detection	1/1	ND	ND	5/5
	Range (mg/kg)	0.360-0.360	ND	ND	0.035-1.000
	Mean[a] (mg/kg)	[b]	ND	ND	0.305
Aroclor-1260	Frequency of Detection	ND	ND	ND	6/6
	Range (mg/kg)	ND	ND	ND	0.035-1.100
	Mean[a] (mg/kg)	ND	ND	ND	0.596
Benzene	Frequency of Detection	ND	ND	ND	1/10
	Range (mg/kg)	ND	ND	ND	0.005-0.005
	Mean[a] (mg/kg)	ND	ND	ND	0.083
Benzo(a)anthracene	Frequency of Detection	ND	ND	ND	4/11
	Range (mg/kg)	ND	ND	ND	0.430-5.400
	Mean[a] (mg/kg)	ND	ND	ND	0.354
Benzo(a)pyrene	Frequency of Detection	ND	ND	ND	4/4
	Range (mg/kg)	ND	ND	ND	0.320-5.100
	Mean[a] (mg/kg)	ND	ND	ND	0.795
Benzo(b)fluoranthene	Frequency of Detection	ND	ND	ND	3/12
	Range (mg/kg)	ND	ND	ND	0.090-4.700
	Mean[a] (mg/kg)	ND	ND	ND	0.264
Benzo(g,h,i)perylene	Frequency of Detection	ND	ND	ND	4/11
	Range (mg/kg)	ND	ND	ND	0.230-3.700
	Mean[a] (mg/kg)	ND	ND	ND	0.301
Benzo(k)fluoranthene	Frequency of Detection	ND	ND	ND	4/11
	Range (mg/kg)	ND	ND	ND	0.510-5.000
	Mean[a] (mg/kg)	ND	ND	ND	0.358

TABLE 4-79B
(Continued)

Organic Chemical		Plant 2/3	Plant 6	Plant 9	Pilot Plant
Benzoic acid	Frequency of Detection	1/3	ND	ND	1/12
	Range (mg/kg)	0.088-0.088	ND	ND	0.059-0.059
	Mean[a] (mg/kg)	1.213	ND	ND	1.122
Carbon disulfide	Frequency of Detection	ND	ND	12/26	2/10
	Range (mg/kg)	ND	ND	0.001-0.013	0.001-0.004
	Mean[a] (mg/kg)	ND	ND	0.003	0.083
Chlorobenzene	Frequency of Detection	ND	ND	ND	1/10
	Range (mg/kg)	ND	ND	ND	0.005-0.005
	Mean[a] (mg/kg)	ND	ND	ND	0.083
Chloroform	Frequency of Detection	ND	2/12	4/26	1/10
	Range (mg/kg)	ND	0.003-0.004	0.005-0.130	0.002-0.002
	Mean[a] (mg/kg)	ND	0.003	0.004	0.083
Chrysene	Frequency of Detection	ND	ND	ND	4/11
	Range (mg/kg)	ND	ND	ND	0.550-7.200
	Mean[a] (mg/kg)	ND	ND	ND	0.391
Bromodichloro-methane	Frequency of Detection	ND	ND	2/26	ND
	Range (mg/kg)	ND	ND	0.007-0.013	ND
	Mean[a] (mg/kg)	ND	ND	0.004	ND
Di-n-butyl phthalate	Frequency of Detection	ND	ND	ND	3/12
	Range (mg/kg)	ND	ND	ND	0.046-1.400
	Mean[a] (mg/kg)	ND	ND	ND	0.415
Di-n-octyl phthalate	Frequency of Detection	ND	1/11	ND	ND
	Range (mg/kg)	ND	0.280-0.280	ND	ND
	Mean[a] (mg/kg)	ND	0.212	ND	ND

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TABLE 4-79B
(Continued)

Organic Chemical		Plant 2/3	Plant 6	Plant 9	Pilot Plant
Dibenzo(a,h) anthracene	Frequency of Detection	ND	ND	ND	2/11
	Range (mg/kg)	ND	ND	ND	0.140-1.500
	Mean[a] (mg/kg)	ND	ND	ND	0.312
Dibenzofuran	Frequency of Detection	ND	ND	ND	3/12
	Range (mg/kg)	ND	ND	ND	0.055-0.640
	Mean[a] (mg/kg)	ND	ND	ND	0.234
Ethyl benzene	Frequency of Detection	1/6	1/12	ND	1/10
	Range (mg/kg)	0.003-0.003	0.002-0.002	ND	0.001-0.001
	Mean[a] (mg/kg)	0.005	0.003	ND	0.082
Fluoranthene	Frequency of Detection	1/3	ND	ND	7/12
	Range (mg/kg)	0.081-0.081	ND	ND	0.043-10.000
	Mean[a] (mg/kg)	0.280	ND	ND	1.279
Fluorene	Frequency of Detection	ND	ND	ND	4/12
	Range (mg/kg)	ND	ND	ND	0.044-1.700
	Mean[a] (mg/kg)	ND	ND	ND	0.322
Indeno(1,2,3-cd)pyrene	Frequency of Detection	ND	ND	ND	4/11
	Range (mg/kg)	ND	ND	ND	0.160-2.900
	Mean[a] (mg/kg)	ND	ND	ND	0.460
Methylene chloride	Frequency of Detection	6/6	10/12	26/26	10/10
	Range (mg/kg)	0.005-0.078	0.004-0.027	0.004-0.025	0.007-6.700
	Mean[a] (mg/kg)	0.017	0.013	0.015	0.683
N-nitroso-di-n-propylamine	Frequency of Detection	1/1	ND	ND	ND
	Range (mg/kg)	0.630-0.630	ND	ND	ND
	Mean[a] (mg/kg)		ND	ND	ND

TABLE 4-79B
(Continued)

Organic Chemical		Plant 2/3	Plant 6	Plant 9	Pilot Plant
N-nitroso-diphenylamine	Frequency of Detection	2/3	ND	ND	ND
	Range (mg/kg)	0.100-0.130	ND	ND	ND
	Mean[a] (mg/kg)	0.197	ND	ND	ND
Phenanthrene	Frequency of Detection	1/1	ND	ND	6/12
	Range (mg/kg)	0.088-0.088	ND	ND	0.140-8.800
	Mean[a] (mg/kg)	[b]	ND	ND	0.384
Phenol	Frequency of Detection	ND	ND	ND	1/12
	Range (mg/kg)	ND	ND	ND	0.069-0.069
	Mean[a] (mg/kg)	ND	ND	ND	0.236
Pyrene	Frequency of Detection	ND	ND	ND	6/12
	Range (mg/kg)	ND	ND	ND	0.083-10.000
	Mean[a] (mg/kg)	ND	ND	ND	0.387
Tetrachloroethene	Frequency of Detection	ND	2/12	1/26	4/10
	Range (mg/kg)	ND	0.002-0.003	0.220-0.220	0.001-17.000
	Mean[a] (mg/kg)	ND	0.003	0.004	0.012
Toluene	Frequency of Detection	4/6	3/12	ND	4/10
	Range (mg/kg)	0.002-0.021	0.002-0.007	ND	0.001-0.010
	Mean[a] (mg/kg)	0.007	0.003	ND	0.083
Total xylenes	Frequency of Detection	1/6	2/12	ND	2/10
	Range (mg/kg)	0.017-0.017	0.003-0.008	ND	0.008-31.000
	Mean[a] (mg/kg)	0.007	0.004	ND	0.008
Tributylphosphate	Frequency of Detection	2/2	ND	ND	ND
	Range (mg/kg)	0.170-2.200	ND	ND	ND
	Mean[a] (mg/kg)	[b]	ND	ND	ND

TABLE 4-79B
(Continued)

Organic Chemical		Plant 2/3	Plant 6	Plant 9	Pilot Plant
Trichloroethene	Frequency of Detection	ND	1/12	5/26	6/10
	Range (mg/kg)	ND	0.200-0.200	0.004-10.000	0.003-2.000
	Mean[a] (mg/kg)	ND	0.004	0.006	0.008
Vinyl chloride	Frequency of Detection	ND	1/12	ND	1/9
	Range (mg/kg)	ND	0.003-0.003	ND	0.007-0.007
	Mean[a] (mg/kg)	ND	0.006	ND	0.006
beta-BHC	Frequency of Detection	ND	3/3	ND	2/12
	Range (mg/kg)	ND	0.021-0.250	ND	0.046-0.220
	Mean[a] (mg/kg)	ND	0.058	ND	0.012
bis(2-ethylhexyl) phthalate	Frequency of Detection	1/3	3/11	1/1	5/12
	Range (mg/kg)	0.180-0.180	0.130-0.380	0.320-0.320	0.046-1.100
	Mean[a] (mg/kg)	0.310	0.208	[b]	0.316

[a]If number of detects <7 or frequency of detection <50%, a geometric mean is given; otherwise, an arithmetic mean is given.
[b]Not applicable if sample size ≤2.
[c]Not detected

Volatile organic compounds samples taken at Waste Pit 1 ranged from 2 to 330 µg/kg (Table 4-79B). The highest concentrations were detected for chloroform and tetrachloroethene. TOC concentrations for Pit 1 measured as high as 33,600 mg/kg.

Radionuclides detected in the berm of Pit 3 included Ra-226 and Ra-228, Th-228, Th-230, Th-232, U-234, U-235/236 and U-238 (Table 4-78). Pu-239/240 was also detected in one sample from this area. Total uranium was also detected in all samples from this area, with a maximum concentration of 969 mg/kg.

The Burn Pit the highest concentrations of several inorganic constituents, including cobalt, copper, molybdenum, and zinc (Table 4-79A, B). PCBs were detected at up to 2,300 µg/kg (aroclor-1254), and TOC was found at up to 152,000 mg/kg. Methylene chloride was also detected in all samples from the Burn Pit, and other organic detections included 2-butanone, acetone, ethylbenzene, toluene and total xylenes.

Samples from the active and inactive fly ash disposal areas contained detectable concentrations of several radionuclides slightly above background levels (Table 4-78). The highest concentrations detected in the active fly ash disposal area were of U-238, while those for the inactive area were of U-234 and U-238.

Antimony, arsenic, lead, molybdenum, selenium and silver exceeded background levels in both fly ash areas (Table 4-79A). The active fly ash pile contained calcium and magnesium above 35,000 mg/kg. The inactive flyash pile had mercury about twice background. Semivolatile organics were detected in higher levels (up to 2,700 µg/kg) in the active flyash pile than in the inactive flyash pile (up to 310 µg/g) (Table 4-79B). Quantitative levels of several volatile organics, including 1,1,1-trichloroethane and methylene chloride, were detected in both areas.

Several radionuclides were detected in the solid waste landfill at levels slightly above background. The highest concentrations detected were of uranium, at 23.3 pCi/g U-234 and 45.2 pCi/g U-238 (Table 4-78).

Calcium and lead concentrations were several times background levels (Table 4-79A). Cyanide was detected in amounts up to 0.79 mg/kg. Measurable amounts of several volatiles were detected, including 1,1-dichloroethane and methylene chloride, but no semivolatiles were detected (Table 4-79B).

Uranium isotopes, thorium-230 and radium-226 were the radionuclides in Plant 2/3 detected in the highest concentrations (Table 4-78). Calcium, lead, magnesium, silver and zinc were at least twice background (Table 4-79A). The range of concentrations for semivolatile compounds was 81 to 630

µg/kg, with concentrations of N-nitroso-di-n-propylamine the highest, followed by bis(2-ethylhexyl) phthalate, benzoic acid, phenanthrene and fluoranthene (Table 4-79B).

Subsurface borings in Plant 6 were concentrated in the wastewater treatment area and two areas where pickling were performed. The highest levels of the isotopes of uranium for RI/FS subsurface sampling were encountered here, with U-234 and U-238 having the highest readings (Table 4-78). Strontium-90 and Tc-99 were also detected in their peak concentrations in Plant 6. Conspicuous in Plant 6 was the presence of Pu-238 at a maximum detection of 158 pCi/g (Table 4-78).

In Plant 6, maximum concentrations of 1,1-dichloroethene, 2-butanone, tetrachlorethene and toluene were below 30 µg/kg, while concentrations of beta-BHC, bis(2-ethylhexyl)phthalate, di-n-octyl phthalate, and trichloroethene exceeded 100 µg/kg (Table 4-79B). HSL inorganic compounds present include aluminum, calcium, cyanide, iron and magnesium (Table 4-79A).

Uranium and thorium isotopes and Ra-228 were the highest concentration radionuclides detected in Plant 9 (Table 4-78). The highest detected concentrations were 118 pCi/g for U-234 and 115 pCi/g of U-238. Calcium levels detected in samples from Plant 9 were over 100,000 mg/kg. All other inorganic constituents were less than background levels (Table 4-79A). Volatile organic concentrations ranged from 1 to 250 µg/kg, with the exception of trichloroethene, which had a maximum concentration of 10,000 µg/kg (Table 4-79B).

The highest concentrations of Cs-137 and Ra-228 were samples from the Pilot Plant (Table 4-78). Above background levels of plutonium were also detected, in concentrations up to 1.65 pCi/g for Pu-239/240 and 19.8 pCi/g for Pu-238.

Volatile organics were found in concentrations of 1 to 31,000 µg/kg in samples from the Pilot Plant, while concentrations of semivolatiles ranged from 46 to 10,000 µg/kg (Table 4-79B). Barium, calcium, lead, mercury, and zinc were detected at twice background levels (Table 4-79A).

4.1.7 Ecology

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4.1.7 Ecology

This section describes results of FEMP-specific ecological studies conducted in support of the FEMP environmental monitoring program and the RI/FS. In order to avoid duplication, those studies summarized in Section 2.0, including Facemire et al. (1990), a jurisdictional wetlands delineation, and surveys for threatened and endangered species, are not presented below. The implications of FEMP ecological studies with respect to ecological risk are discussed in Part II, Section 6.0, Ecological Assessment.

4.1.7.1 Ecological Characterization Studies

Benthic Macroinvertebrate Surveys of the Great Miami River and Paddys Run

A complete report on this study is presented in Appendix D. Water quality and ICI data are summarized below.

Water Quality Data

Water quality variables measured in both the Great Miami River and Paddys Run fell within ranges typical of well buffered freshwater ecosystems (Wetzel 1975). Table 4-80A summarizes Great Miami River data for each sampling station averaged across sampling times, and Table 4-80B summarizes the values for each sampling time averaged across stations. Raw data for all sampling times and stations are presented in Appendix D, Attachment D.II.

In general, variable ranges were greater over time than between stations, and consistent differences among stations were not observed. For example, mean Secchi depth ranged from 0.03 to 0.79 m over time (Table 4-80A), but ranged only from 0.37 to 0.51 among stations (Table 4-80B). Secchi depth and current velocity showed no consistent variation seasonally or among stations (Tables 4-80A,B), but velocity at different stations did tend to covary through time (Appendix D, Attachment D.II). Mean temperature during the study period ranged from 5.55 to 24.6 C (Table 4-80B), with only a 1-2 °C difference among stations (Table 4-80A; Appendix D, Attachment D.II).

Overall, ranges of water quality variables in Paddys Run were similar to those in the Great Miami River (Tables 4-81A,B), given the more limited data available for comparison in Paddys Run. Raw data for all sampling times and stations are presented in Appendix D, Attachment D.II. It is difficult to make generalizations about seasonal and spatial variations in Paddys Run water quality, due to the limited data available for the stations downstream from PR-3. Secchi depth and current velocity were highly variable both among stations and through time (Tables 4-81A,B). The remaining variables tended to vary more through time than among stations, consistent with the pattern observed for the Great Miami River. However, clear patterns of seasonal variability were not observed for variables other than temperature (Table 4-81B). This reflects both the highly variable flow in Paddys Run and the gaps in data for the lower stations. These data gaps are themselves a result of the variable flow, as stations were omitted only when they were dry.

TABLE 4-80A

GREAT MIAMI RIVER WATER QUALITY DATA, AVERAGED ACROSS TIMES FOR EACH SAMPLING STATION

	Secchi Depth (m)			Current Velocity (feet/s)			Temperature (°C)		
Station	Range	Mean	SD	Range	Mean	SD	Range	Mean	SD
W-1	0.1 - 1.0	0.49	0.26	0.3 - 3.03	1.19	0.95	3.8 - 24.3	14.3	7.8
GMR-1	0 - 0.7	0.45	0.25	0.2 - 1.38	0.91	0.97	2.5 - 23.8	14.1	7.9
GMR-2	0 - 0.7	0.43	0.24	1.1 - 3.13	2.10	0.91	2.8 - 23.6	14.1	7.8
GMR-3	0.1 - 0.8	0.41	0.20	0.5 - 3.13	1.77	0.94	2.8 - 24.9	14.3	8.0
W-3	0 - 1.1	0.51	0.38	0.7 - 4.0	1.46	1.26	2.6 - 25.1	14.3	8.3
GMR-4	0 - 0.8	0.37	0.26	0 - 3.17	1.01	1.15	2.8 - 25.3	15.7	8.1
W-4	0 - 1.4	0.51	0.43	0.2 - 3.32	1.35	0.94	3.1 - 25.6	14.8	8.5

	Dissolved Oxygen (mg/ℓ)			pH			Conductivity (µmhos)			Oxidation Reduction Potential (Volts)		
Station	Range	Mean	SD	Range	Mean	SD	Range	Mean	SD	Range	Mean	SD
W-1	7.71 - 13.12	10.38	1.81	7.72 - 8.58	8.12	0.30	529 - 985	801	145	0.163 - 0.318	0.242	0.069
GMR-1	7.67 - 12.68	10.41	1.79	7.81 - 8.5	8.22	0.25	556 - 985	796	144	0.160 - 0.312	0.221	0.064
GMR-2	7.68 - 12.96	10.28	1.64	7.62 - 8.68	8.22	0.34	357 - 986	772	198	0.175 - 0.308	0.231	0.056
GMR-3	7.55 - 13.0	11.19	1.89	7.88 - 8.68	8.25	0.33	513 - 978	790	155	0.140 - 0.302	0.223	0.060
W-3	7.71 - 15.8	11.85	2.49	7.9 - 8.63	8.25	0.31	617 - 968	800	130	0.150 - 0.292	0.225	0.059
GMR-4	7.60 - 15.4	11.21	2.80	7.89 - 8.53	8.27	0.33	633 - 953	794	120	0.151 - 0.295	0.228	0.060
W-4	7.70 - 18.4	12.13	3.49	7.54 - 8.56	8.16	0.46	627 - 950	802	117	0.170 - 0.288	0.229	0.049

TABLE [illegible]B

GREAT MIAMI RIVER WATER QUALITY DATA
AVERAGED ACROSS STATIONS FOR EACH SAMPLING TIME

Date	Secchi Depth (m)			Current Velocity (feet/s)			Temperature (°C)		
	Range	Mean	SD	Range	Mean	SD	Range	Mean	SD
December 1988	0.25 - 0.5	0.4	0.07	0.07 - 3.25	1.02	1.08	4.8 - 5.91	5.55	0.38
June 1989	0 - 0.1	0.03	0.05	0.7 - 6.0	3.27	1.23	19.5 - 20.6	19.9	0.34
November 1989	0.2 - 0.7	0.51	0.19	0 - 4.5	1.19	1.21	11.6 - 12.6	12.2	0.28
December 1989	0.5 - 1.1	0.79	0.2	0.05 - 1.1	0.48	0.35	2.51 - 3.8	2.92	0.43
March 1990	0.5 - 1.4	0.79	0.32	0 - 2.1	0.9	0.85	9.72 - 10.2	9.92	0.15
May 1990	0.45 - 0.7	0.52	0.06	0.1 - 4.6	2.19	1.13	14.2 - 16.2	16.0	0.42
June 1990	0.2 - 0.4	0.26	0.08	0.1 - 1.5	0.74	0.48	22.8 - 25.6	23.7	1.06
August 1990	0.2 - 0.5	0.31	0.09	0 - 3.7	1.39	1.03	23.6 - 26.2	24.6	0.73

Date	Dissolved Oxygen (mg/ℓ)			pH			Conductivity (µmhos)			Oxidation Reduction Potential (Volts)		
	Range	Mean	SD	Range	Mean	SD	Range	Mean	SD	Range	Mean	SD
December 1988	12.3 - 13.3	12.8	0.29	7.27 - 8.67	8.1	0.3	854 - 877	862	6.69	-0.473 - 2.0	0.3628	0.6168
June 1989	7.43 - 7.85	7.66	0.1	7.12 - 7.9	7.77	0.19	204 - 635	547	127	0.167 - 0.208	0.19	0.0119
November 1989	8.22 - 13.2	9.37	1.12	7.03 - 8.25	8.07	0.27	933 - 987	970	19.9	0.276 - 0.315	0.2907	0.0086
December 1989	11.6 - 13.1	12.4	0.56	8.01 - 8.14	8.08	0.06	943 - 953	949	3.69	0.288 - 0.318	0.3017	0.0115
March 1990	10.0 - 11.3	10.7	0.47	7.8 - 8.48	8.28	0.24	826 - 844	840	6.47	0.243 - 0.317	0.2633	0.0253
May 1990	9.0 - 10.8	9.93	0.57	8.13 - 8.99	8.61	0.18	764 - 771	769	1.89	0.178 - 0.21	0.1861	0.0079
June 1990	9.8 - 18.4	13.4	3.26	a	a	a	650 - 700	671	26.7	a	a	a
August 1990	9.35 - 16.6	12.4	2.0	8.4 - 8.68	8.55	0.08	711 - 768	749	17.7	0.139 - 0.179	0.1583	0.0127

[a] No data

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TABLE [illegible]A
PADDYS RUN WATER QUALITY DATA
AVERAGED ACROSS TIMES FOR EACH SAMPLING STATION

	Secchi Depth (m)			Current Velocity (feet/s)			Temperature (°C)		
Station	Range	Mean	SD	Range	Mean	SD	Range	Mean	SD
PR-1	0.2 - 1.0	0.46	0.26	0.1 - 0.6	0.3	0.16	0 - 20.5	12.4	7.9
PR-2	0.25 - 1.0	0.55	0.32	0 - 1.2	0.31	0.41	0 - 22.4	11.9	8.7
PR-3	0.2 - 1.2	0.61	0.45	0.1 - 0.6	0.31	0.16	0 - 23.5	13.9	9.0
PR-4	0.1 - 0.8	0.37	0.32	0 - 2.5	0.7	1.02	8.9 - 23.6	15.7	6.9
PR-5	0.1 - 1.1	0.55	0.41	0 - 0.8	0.32	0.30	7.2 - 23.5	16.0	8.6
PR-6	0.1	0.1	a	2.1	2.1	a	20.8	20.8	a
PR-7	0.2 - 1.0	0.56	0.34	0 - 1.4	0.43	0.53	6.9 - 20.8	15.0	5.5
PR-8[b]	0.1 - 0.4	0.25	0.21	0.8 - 2.1	1.45	0.92	20.7 - 21.1	20.9	0.3

	Dissolved Oxygen (mg/ℓ)			pH			Conductivity (µmhos)			Oxidation Reduction Potential (Volts)		
Station	Range	Mean	SD	Range	Mean	SD	Range	Mean	SD	Range	Mean	SD
PR-1	7.58 - 16.3	10.43	3.21	6.96 - 8.99	7.92	0.65	164 - 699	596	193	0.183 - 0.287	0.235	0.039
PR-2	8.2 - 12.92	9.7	1.59	7.62 - 8.59	7.93	0.33	184 - 705	593	187	0.178 - 0.323	0.255	0.059
PR-3	8.5 - 14.4	10.39	2.10	7.68 - 8.9	8.16	0.44	230 - 681	590	161	0.171 - 0.283	0.222	0.042
PR-4	7.15 - 15.33	11.58	3.61	7.77 - 8.73	8.24	0.44	498 - 673	614	71	0.182 - 0.246	0.204	0.030
PR-5	8.35 - 15.26	10.42	2.81	7.76 - 8.44	8.17	0.29	550 - 690	646	57	0.178 - 0.255	0.217	0.043
PR-6	7.0	7.0	a	7.85	7.85	a	486	486	a	0.185	0.185	a
PR-7	6.41 - 12.64	8.84	2.17	7.25 - 7.85	7.57	0.24	108 - 742	565	218	0.192 - 0.376	0.267	0.066
PR-8[b]	7.23 - 12.2	9.72	3.51	7.81 - 8.14	7.98	0.23	483 - 691	587	147	0.187 - 0.193	0.190	0.004

[a] Sampled only during June 1989

[b] Sampled only during June 1989 and August 1990

TABLE 4-81B

PADDYS RUN WATER QUALITY DATA
AVERAGED ACROSS STATIONS FOR EACH SAMPLING TIME

Date	Secchi Depth (m)			Current Velocity (feet/s)			Temperature (°C)		
	Range	Mean	SD	Range	Mean	SD	Range	Mean	SD
June 1989	0.1 - 1.0	0.33	0.31	0.1 - 2.5	1.29	0.95	19.1 - 23.3	21.0	1.36
November 1989	0.25 - 0.3	0.26	0.02	0 - 0.7	0.32	0.24	8.83 - 11.1	10.2	0.88
December 1989	0.5 - 1.2	0.8	0.36	0 - 0.3	0.19	0.13	0 - 6.92	1.73	3.46
March 1990	0.4 - 1.1	0.68	0.25	0.1 - 0.6	0.28	0.17	5.37 - 9.85	8.18	1.63
April 1990	0.3 - 1.0	0.65	0.29	0.3 - 1.4	0.59	0.44	14.9 - 23.6	19.3	3.64
June 1990	0.1 - 1.0	0.27	0.36	0 - 0.3	0.15	0.12	18.9	18.9	a
August 1990	0.4 - 1.0	0.7	0.28	0.1 - 0.8	0.28	0.3	18.3 - 23.5	20.7	1.86

Date	Dissolved Oxygen (mg/ℓ)			pH			Conductivity (µmhos)			Oxidation Reduction Potential (Volts)		
	Range	Mean	SD	Range	Mean	SD	Range	Mean	SD	Range	Mean	SD
June 1989	6.14 - 9.54	7.75	1.13	7.71 - 8.08	7.88	0.14	483 - 699	590	104	0.171 - 0.192	0.182	0.006
November 1989	7.76 - 9.44	8.66	0.65	6.96 - 7.77	7.53	0.31	108 - 676	578	230	0.246 - 0.313	0.277	0.029
December 1989	6.88 - 12.6	9.34	2.4	7.25 - 7.77	7.61	0.24	164 - 742	330	276	0.283 - 0.376	0.308	0.046
March 1990	12.6 - 16.3	14.5	1.45	7.72 - 8.52	8.22	0.35	656 - 705	678	17.8	0.205 - 0.323	0.247	0.042
April 1990	9.28 - 11.6	10.7	0.86	7.65 - 8.44	8.15	0.31	637 - 670	658	14.4	0.18 - 0.237	0.204	0.021
June 1990	8.3 - 15.2	9.88	2.62	7.85 - 8.99	8.56	0.42	550 - 600	575	27.4	b	b	b
August 1990	8.54 - 12.2	10.1	1.58	7.32 - 8.14	7.74	0.33	628 - 701	680	29.7	0.193 - 0.233	0.216	0.018

[a] Data only for Station PR-7

[b] No data

Invertebrate Community Index

The details of ICI calculations are provided in Appendix D, Attachment D.I. OEPA (1988b) recommends that data collection for ICI calculation be carried out between June 15 and September 30. OEPA descriptions of ICI ranges representing poor, fair, good, or exceptional water quality are based on samples collected during this period. Seasonal variations in ICI therefore do not necessarily indicate changes in water quality, but rather variations in the physical conditions (e.g. temperature) to which organisms are exposed. The use of descriptive terms for water quality below is intended to highlight differences among stations within a given sampling period, rather than drawing any conclusions about seasonal variability in water quality of the Great Miami River or Paddys Run.

ICI results for the Great Miami River are presented in Table 4-82 and are plotted against river miles in Figure 4-7. ICI values depend primarily upon artificial substrate data, and therefore no index calculation was possible where the substrate was not recovered. All Great Miami River artificial substrates were lost during the May - June 1989 sampling period. In the October - December 1988 sampling, all substrates were recovered with the exception of GMR-4. The indices for the two upstream reference stations (W-1, GMR-1) were consistent with fair water quality (OEPA 1988b). The index for the outfall station GMR-2 was the lowest of all Great Miami River samples collected in this survey. Indices for the downstream stations suggested recovery, with the maximum downstream value at Station W-3. However, this apparent pattern did not occur in subsequent sampling events and may be an artifact of the small number of taxa recorded in this sampling (Appendix D, Table D.3-7).

In contrast to October - December 1988, the ICIs calculated from the November - December 1989 data were higher for the FEMP outfall station, GMR-2, than for the station directly upstream of the outfall, GMR-1 (Table 4-82, Figure 4-7). However, these samples also contained few taxa (Appendix D, Table D.3-7). In March - May 1990, artificial substrates were recovered from only three of the seven stations. The ICIs calculated from these data fall into the range considered by OEPA (1988b) to reflect "fair" water quality. All artificial substrates were recovered in June - August 1990, allowing calculation of ICIs for all stations. All values were within the range suggesting fair water quality (OEPA 1988b). However, there was a 50 percent decrease in the ICI between upstream reference station W-1 and the second reference station, GMR-1, which is located approximately 1000 feet upstream of the FEMP outfall, to a value on the border between fair and poor. The ICI increased at the outfall station, GMR-2, and was 20 or greater at all downstream stations. Overall, the ICI values for the Great Miami River suggest that the FEMP discharge at RM 24.1 has minimal impact on the macroinvertebrate community.

Summary ICI results for Paddys Run are presented in Table 4-83 and are plotted against stream miles in Figure 4-8. In May - June 1989, only three artificial substrates were recovered. Unusually heavy rains occurred at this time and Paddys Run was very high and turbid for much of the substrate

TABLE 4-82
GREAT MIAMI RIVER
INVERTEBRATE COMMUNITY INDEX (ICI)

Station	River Mile	Oct.-Dec. 1988	May-June 1989	Nov.-Dec. 1989	Mar.-May 1990	June-Aug. 1990
W-1	25.7	30	ND[a]	20	16	24
GMR-1	24.2	20	ND	10	18	12
GMR-2	24.1	6	ND	22	ND	18
GMR-3	23.2	18	ND	10	14	24
W-3	20.8	22	ND	ND	ND	20
GMR-4	19.6	ND	ND	ND	ND	26
W-4	15.0	14	ND	24	ND	20

[a] No data-artificial substrate not recovered.

TABLE 4-83
PADDYS RUN
INVERTEBRATE COMMUNITY INDEX (ICI)

Station	Stream Mile	May-June 1989	Nov.-Dec. 1989	Mar.-May 1990	June-Aug. 1990
PR-1	3.5	ND[a]	10	14	24
PR-2	3.4	28	14	28	26
PR-3	3.1	8	12	ND	26
PR-4	2.6	4	6	14	ND
PR-5	2.2	ND	ND	20	ND
PR-7	0.98	ND	10	4	8

[a] No data-artificial substrate not recovered or station dry.

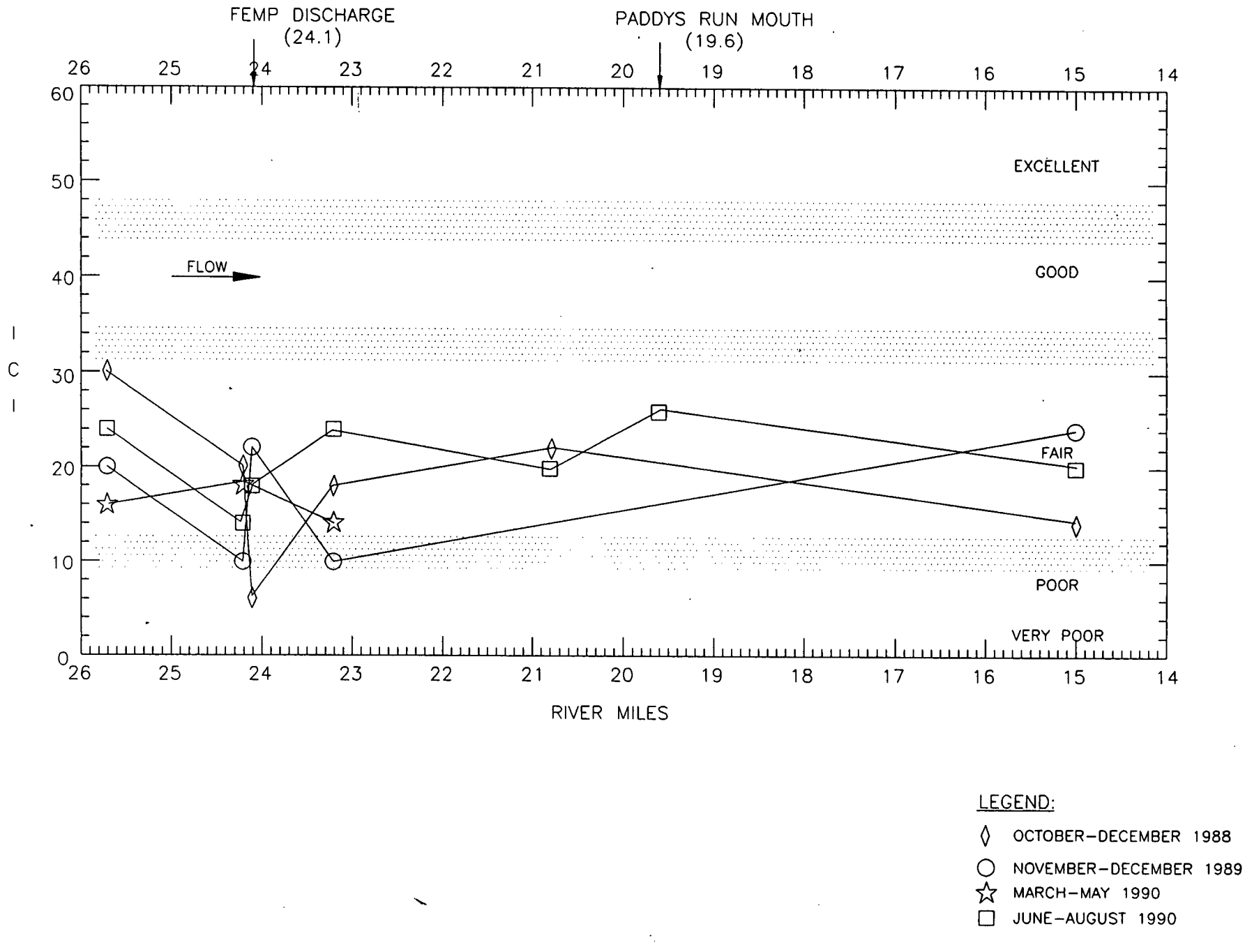

FIGURE 4-7 LONGITUDINAL TREND OF THE INVERTEBRATE COMMUNITY INDEX (ICI) FOR THE GREAT MIAMI RIVER

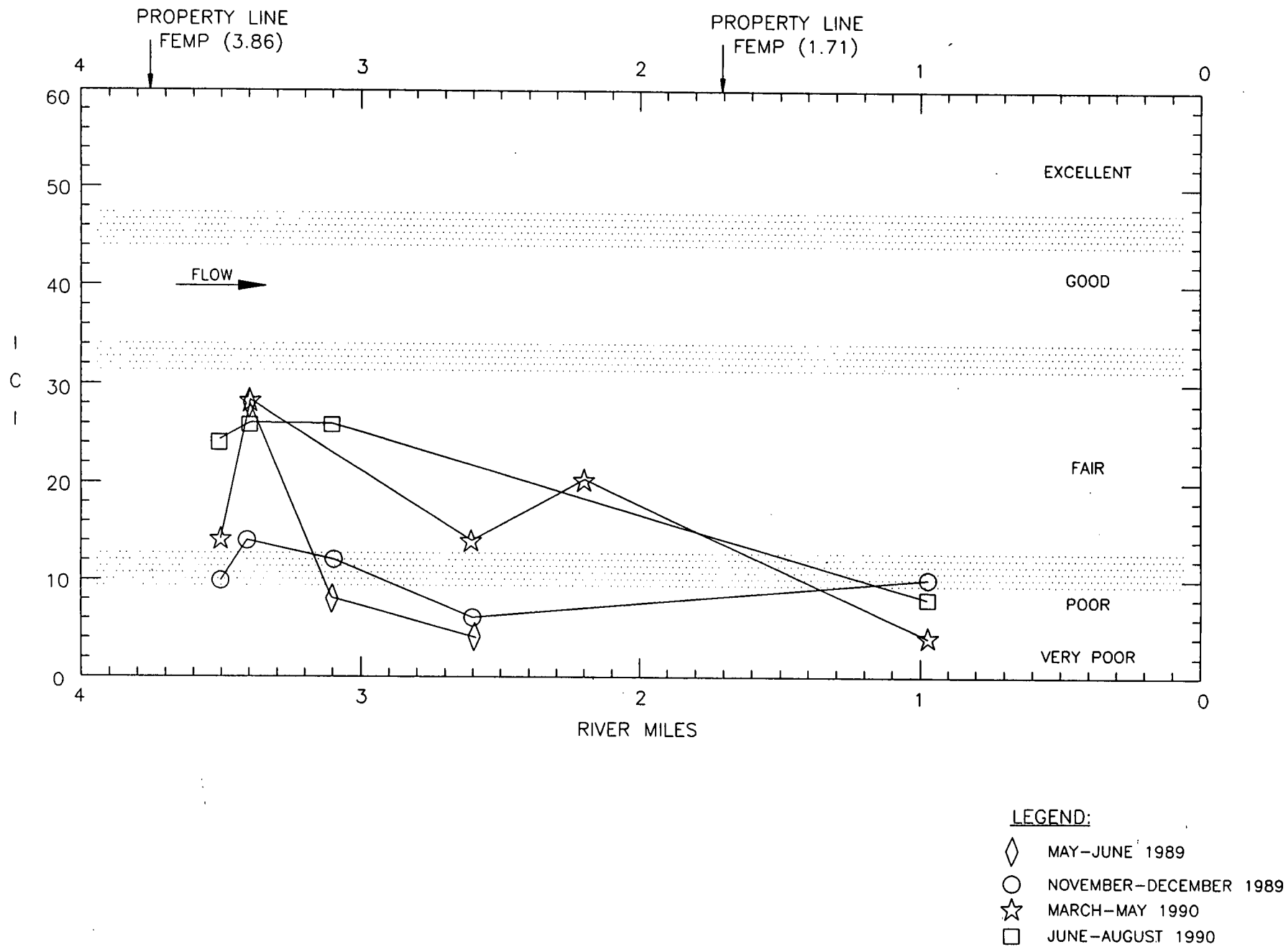

FIGURE 4-8 LONGITUDINAL TREND OF THE INVERTEBRATE COMMUNITY INDEX (ICI) FOR PADDYS RUN

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colonization period. Nevertheless, the ICI for Station PR-2 was 28, one of the highest recorded. At PR-3 and PR-4, the index dropped to levels which would suggest "poor" water quality according to OEPA (1988b) criteria. The November - December 1989 sampling took place during cold weather, and Paddys Run was frozen at the time of substrate retrieval. The ICI values from these samples are quite low, with only the PR-2 index falling into the fair water quality range. This suggests that seasonal temperature variations may cause stresses on macroinvertebrate communities comparable to those caused by pollution. The remaining two Paddys Run samplings (March - May and June - August 1990) were conducted during relatively mild weather, and the ICI values generally indicate fair water quality. Notable is the ICI increase between PR-1 and PR-2, and the low indices for downstream Station PR-7. The ICIs calculated for both 1990 data sets suggest poor water quality at this station (Figure 4-8). At the time of artificial substrate retrieval in August 1990, Paddys Run was dry at Stations PR-4 and PR-5, and ICI calculations were not possible.

All the taxa counts for the October - December 1988 artificial substrate data were relatively low, and the importance of each to the ICI scores increased accordingly (Appendix D). For example, the sample from Station W-3 contained only five taxa but had an ICI value of 22, the second highest. The five taxa present were members of high scoring groups (mayfly, caddisfly, midge). Compared to ICI values, diversity indices calculated for the 1988 data (Appendix D, Table D.3-18) show less variation, with the exception of Station W-3, where the low taxa count resulted in a low diversity index.

4.1.7.2 Contaminant Uptake Studies

This section presents a summary of the results of radionuclide and chemical analyses of biological samples collected at the FEMP and vicinity. The data presented are from WMCO and NLO Environmental Monitoring Reports and RI/FS biological sampling.

Annual Environmental Monitoring Reports

Uranium concentrations in grass and forage samples collected for routine environmental monitoring from 1985 to 1990 ranged from less than 0.01 to 5.6 pCi/g (Table 4-84) and typically declined sharply with distance from the center of the FEMP (Figure 4-8). Fluoride concentrations in these samples ranged from less than 0.02 to 18 mg/kg (Table 4-84). Environmental monitoring data suggest a gradual decline in average uranium and fluoride concentrations in forage over time. However, fluoride in forage showed no relationship with distance from the FEMP (for example, WMCO 1990).

Produce samples collected for the environmental monitoring program typically had uranium concentrations less than the 0.6 pCi/g detection limit for RI/FS data, discussed below, as illustrated by Table 4-85. No consistent differences have been observed in produce uranium concentrations between samples collected adjacent to the FEMP and at reference locations greater than 16 km (10 miles) from the facility.

TABLE 4-84
URANIUM AND FLUORIDE IN GRASS AND FORAGE AT VARYING DISTANCES FROM THE FEMP[a]

			Uranium		Fluoride	
Year	Number of Samples	Distance Range (km)	Average Concentration (pCi/g Dry Weight)	Concentration Range (pCi/g Dry Weight)	Average Concentration (mg/kg)	Concentration Range (mg/kg)
1985	28	0.7 -10.5	0.53	0.02 - 2.34	5.67[b]	<2.4 - 14.0
1986	20	0.7 - 8.7	0.83	0.06 - 4.29	5.3	3.8 - 7.6
1987	20	0.7 - 8.7	0.32	0.02 - 1.03	4.43	2.49 - 11.9
1988	28	0.10 - 40	0.59[b]	<0.03[c] - 5.6	5.4[b]	<0.02 - 18
1989	30	0.10 - 40	0.19[b]	<0.01 - 2.9	3.1[b]	<1.7 - 12
1990	30	0.10 - 40.0	0.03[b]	<0.01 - 0.48	1.8	0.6 - 4.6

[a] Plant material primarily brome grass (Bromus spp.), but other genera represented: Allium, Daucus, Hordeum, Medicago, Melilotus, Poa, Secale, and Triticum.

[b] Average concentration calculated using the detection limit for those samples with uranium or fluoride concentrations below detectable levels.

[c] Concentration less than stated detection limit.

SOURCE: WMCO (1986, 1987, 1988, 1989, 1990, 1991)

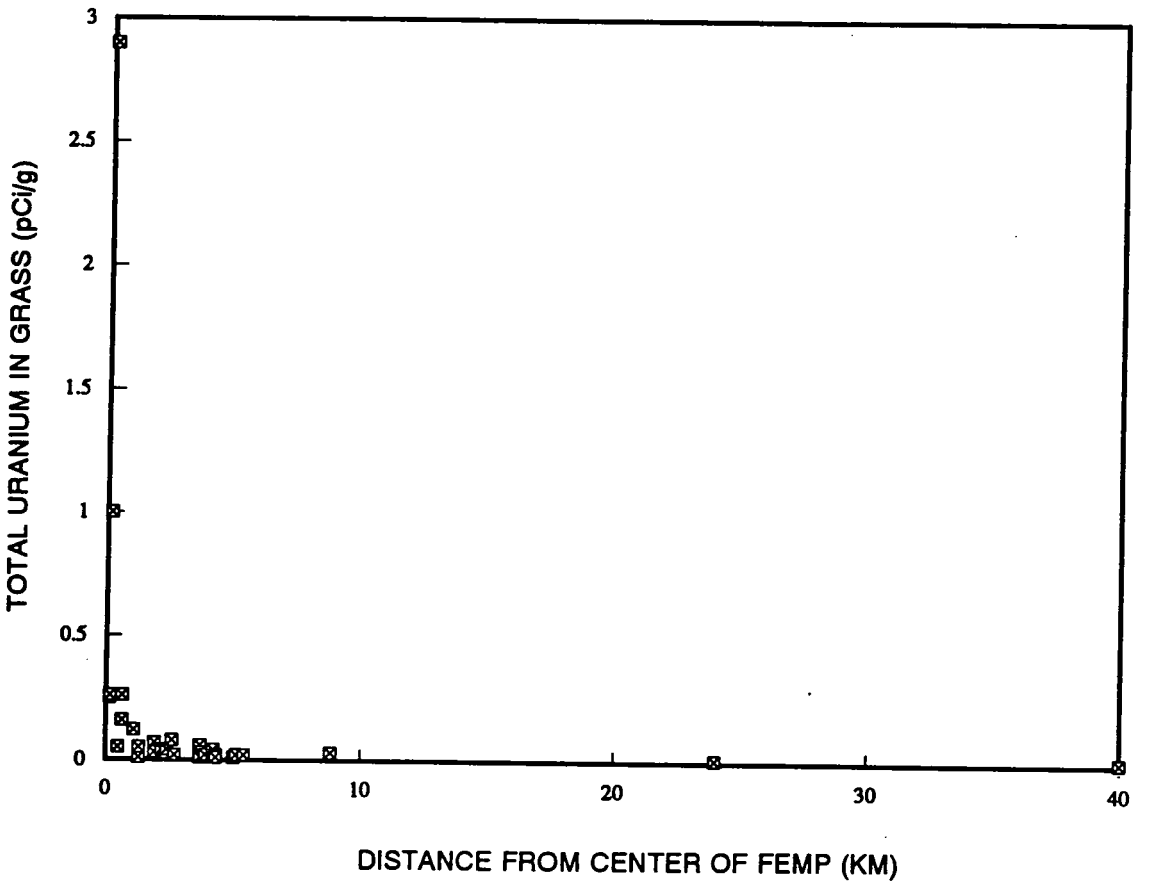

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FIGURE 4-9 TOTAL URANIUM IN GRASS VS DISTANCE FROM THE FEMP – WEMCO

TABLE 4-85
URANIUM CONCENTRATIONS IN PRODUCE
COLLECTED FROM THE FEMP VICINITY AND REFERENCE LOCATIONS

Sample	Year	Range (pCi/g) FEMP Vicinity	Range (pCi/g) Reference Locations[a]
Corn	1987	0.0052	b
	1988	<0.014[c]	b
	1989	0.0012 - 0.0082	0.0030 - 0.0039
	1990	0.0064 - 0.20	0.0038
Potatoes	1987	<0.0007 - 0.0051	b
	1988	<0.014 - 0.028	b
	1989	0.018 - 0.057	0.030 - 0.12
	1990	0.012 - 0.029	0.068
Tomatoes	1987	0.0007 - 0.0074	b
	1988	<0.014 - 0.037	<0.014 - 0.014
	1989	0.017 - 0.070	0.0087 - 0.024
	1990	<0.004 - 0.13	0.0064 - 0.027

[a] 1988, greater than or equal to 24 km from the FEMP.
1989, greater than or equal to 16 km from the FEMP.

[b] Not sampled.

[c] <, concentration less than stated detection limit.

SOURCE: WMCO (1988, 1989, 1990, 1991)

NLO and WMCO have conducted radionuclide analyses of milk from cows grazing in the vicinity of the FEMP since 1983 (NLO 1984, 1985, WMCO 1986-1991). Samples were also collected from several reference sites (Table 4-86). Samples from the vicinity of the FEMP either had no detectable uranium or were similar to the reference locations, except in 1989 and 1990. Single samples collected in 1989 and 1990 from the FEMP had uranium concentrations of 12.8 pCi/ℓ and 11.0 pCi/ℓ, respectively, but WMCO (1990, 1991) concluded that these values were incorrect since other samples were below detection limits and air monitoring equipment detected no uranium releases from the FEMP.

Fish were sampled from the Great Miami River upstream, at, and downstream from the FEMP effluent discharge from 1984 to 1990 (NLO 1985, WMCO 1986-1991). There were no consistent differences among the three locations, although fish collected from the outfall and downstream stations markedly higher uranium concentrations than those from the upstream station in 1988 (Table 4-87). Most of the fish uranium values reported by NLO and WMCO were below the detection limit of 0.6 pCi/g for RI/FS data (Table 4-87).

Radionuclide and Chemical Analyses of RI/FS Biological Samples from the FEMP and Vicinity

Concentrations of radionuclides and nonradioactive constituents in FEMP vegetation were measured in 1987 and 1988, when the plant was still in operation. Ninety-six samples of terrestrial vegetation and 17 samples of wetland vegetation were analyzed for radionuclides (Tables 4-88, 4-89, Figure 3-60). Ten samples, including two from a wetland site, were analyzed for selected inorganic (Table 4-90) and organic chemicals. Total isotopic uranium concentrations in terrestrial plants ranged from less than detection limits of 0.6 pCi/g to 35.5 pCi/g in a forb root sample from Site 28, adjacent to the confluence of the storm sewer outfall ditch and Paddys Run (Table 4-88, Figure 3-60). Total isotopic uranium in wetland plants ranged from less than the detection limit of 0.6 pCi/g to 31.3 pCi/g in a grass root sample from Site 9A (Table 4-89, Figure 3-60). Cesium-137 ranged from less than detection limits (0.2 to 0.8 pCi/g) to 1.4 pCi/g in terrestrial plants and was not detected in wetland plants (Tables 4-88, 4-89). Strontium-90 was detected in only seven terrestrial plant samples and one wetland sample (Tables 4-88, 4-89). The range of detected strontium-90 concentrations, 0.6 to 0.9 pCi/g, was smaller than the range of detection limits, 0.5 to 1.5 pCi/g. Complete results of vegetation analyses are presented in Appendix H.

Aluminum, arsenic, barium, fluoride, sulfate, mercury and zinc were detected in vegetation from all five locations sampled (Table 4-90, Appendix H). Fluoride concentrations in RI/FS samples were ten-fold higher than those in WMCO environmental monitoring samples (Tables 4-90, 4-84). The reason for this is unknown. Cadmium, lead, and vanadium were detected in several samples, but silver was not. The areas with the highest concentrations of inorganic chemicals in leaves were Site 3, north of the sanitary landfill and Site 28, adjacent to the confluence of the storm sewer outfall ditch and Paddys Run (Figure 3-60). The highest inorganic chemical concentrations in roots occurred at Site 10, east of

TABLE 4-86
URANIUM IN MILK

Year	FEMP Location[a]			Reference[b]		
	Frequency of Detection	Average Concentration (pCi/ℓ)	Concentration Range (pCi/ℓ)	Frequency of Detection	Average Concentration (pCi/ℓ)	Concentration Range (pCi/ℓ)
1983	1/4	0.86	0.7 - 1.35	1/4	0.86	<0.7 - 1.35
1984	0/5	0.68	<0.68[d]	0.5	0.68	<0.68
1985	0/3	0.68	<0.68	0/3	0.68	<0.68
1986	0/6	<6.8	<6.8	0/6	6.8	<0.68
1987	e	<0.7	e	e	0.7	e
1988	1/12	0.7	<0.7 - 1.0	0/12	0.7	<0.7
1989	1/12	1.7	<0.7 - 12.8	1/12	0.8	<0.7 - 1.9
1990	6/11	1.8	<0.68 - 11.0	4/11	1.0	<0.68 - 3.7

[a] Dairy farm adjacent to the FEMP.

[b] Dairy farm in Kentucky approximately 30 km southeast of the FEMP in 1983-1986; dairy farm in Indiana approximately 30 km west of the FEMP, 1987-1989; dairy farm 37 km west-southwest of the FEMP, 1990.

[c] Average concentration calculated using the detection limit for those samples with uranium concentrations below detectable levels.

[d] Concentration less than stated detection limit.

[e] Not stated.

SOURCE: NLO (1984, 1985), WMCO (1986, 1987, 1988, 1989, 1990, 1991)

TABLE 4-87
URANIUM CONCENTRATION IN FISH
COLLECTED FROM THE GREAT MIAMI RIVER[a]

Year	Sampling Location[b]	Number of Samples	Average Concentration (pCi/g Dry Weight)	Concentration Range (pCi/g Dry Weight)
1984	Upstream	11	0.331	0.221 - 0.550
	Outfall	11	0.299	0.067 - 0.747
	Downstream	14	0.242	0.132 - 0.777
	Total	36	0.291	0.067 - 0.777
1985	Upstream	16	0.086	0.039 - 0.173
	Outfall	21	0.156	0.064 - 0.344
	Downstream	17	0.109	0.067 - 0.280
	Total	54	0.117	0.039 - 0.344
1986	Upstream	25	0.07	0.02 - 0.1
	Outfall	23	0.06	0.03 - 0.1
	Downstream	25	0.02	0.04 - 0.2
	Total	73	0.05	0.002 - 0.2
1987	Upstream	17	0.0050	0.0004 - 0.0494
	Outfall	21	0.0047	0.0009 - 0.0181
	Downstream	23	0.0059	0.0007 - 0.0214
	Total	61	0.0052	0.0004 - 0.0494
1988	Upstream	24	0.28	0.0014 - 5.3
	Outfall	26	2.3	0.15 - 13.3
	Downstream	16	1.7	0.0036 - 4.1
	Total	66	1.4	0.014 - 13.3
1989	Upstream	19	0.0080	0.0027 - 0.015
	Outfall	20	0.010	0.0018 - 0.032
	Downstream	17	0.024	0.0044 - 0.051
	Total	56	0.014	0.0018 - 0.051
1990	Upstream	25	0.059	0.0038 - 0.60
	Outfall	20	0.0084	0.0022 - 0.021
	Downstream	35	0.016	0.0030 - 0.027
	Total	80	0.028	0.0030 - 0.216

[a] Fish sampled included the following families: Cyprinidae (carp), Catastomidae (carpsucker, redhouse), Centrarchidae (bass, sunfish), Sciaenidae (drum), Clupeidae (gizzard shad), and Ictaluridae (catfish).

[b] Fish were sampled in the Great Miami River at three locations: 1) Mile 27.0, 2.4 km upstream of the FEMP effluent outfall; 2) Mile 24.1, the FEMP effluent outfall; and 3) Mile 19.5, Paddys Run confluence.

SOURCE: NLO (1985), WMCO (1986, 1987, 1988, 1989, 1990, 1991)

TABLE 4-88
RADIONUCLIDE CONCENTRATIONS IN TERRESTRIAL VEGETATION ON THE FEMP (RI/FS SAMPLING)

Radionuclide	Parameter	Grass Leaves	Grass Roots	Forb Leaves	Forb Roots
Total Uranium	Frequency of Detection	15/30	22/30	12/18	15/18
	Concentration Range (pCi/g)[a]	<0.6[b] - 15.7	<0.6 - 31.9	<0.6 - 6.4	<0.6 - 35.5
	Average(pCi/g)[c]	2.2	7.5	2.3	9.5
Cesium-137	Frequency of Detection	1/26	19/27	1/18	3/18
	Concentration Range (pCi/g)	<0.2 - 0.4	<0.2 - 1.4	<0.2 - 0.4	<0.2 - 0.8
	Average (pCi/g)	0.3	0.5	0.3	0.4
Strontium-90	Frequency of Detection	1/30	1/31	3/18	2/18
	Concentration Range (pCi/g)	<0.5 - <1.5	<0.2 - 0.8	<0.5 - <1.0	<0.5 - <1.4
	Average (pCi/g)	0.7	0.6	0.6	0.6

[a] pCi per gram dry weight.

[b] Concentration less than stated detection limit.

[c] Arithmetic mean. Includes detection limit for samples below detection limits.

TABLE 4-89
RADIONUCLIDE CONCENTRATIONS IN WETLAND PLANTS ON THE FEMP
(RI/FS SAMPLING)

		Algae	Cattail Leaf	Cattail Root	Sedge Leaf	Grass Leaf	Grass Root
Total Uranium	Frequency of Detection	0/2	3/5	2/4	0/2	0/2	2/2
	Concentration Range (pCi/g)[a]	<0.6[b]	<0.6 - 3.3	<0.6 - 6.4	<0.6	<0.6	5.1 - 31.3
	Average (pCi/g)[c]	0.6	1.3	2.9	0.6	0.6	18.2
Cesium-137	Frequency of Detection	0/2	0/5	0/4	0/2	0/2	0/2
	Concentration Range (pCi/g)	<0.2	<0.2 - <0.6	<0.2 - <0.3	<0.2	<0.2 - <0.3	<0.2
	Average (pCi/g)	0.2	0.4	0.2	0.2	0.25	0.2
Strontium-90	Frequency of Detection	1/2	0/5	0/4	0/2	0/2	0/2
	Concentration Range (pCi/g)	<0.5 - 0.9	<0.5 - <1.0	<0.5 - <0.9	<0.7 - <1.3	<0.5 - <0.6	<0.5
	Average (pCi/g)	0.7	0.8	0.6	1.0	0.55	0.5

[a] pCi per gram dry weight.

[b] Concentration less than stated detection limit.

[c] Arithmetic mean. Includes detection limit for samples below detection limits.

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TABLE 4-90
INORGANIC CHEMICAL CONCENTRATIONS IN VEGETATION ON THE FEMP
(RI/FS SAMPLING)

	Grass Leaves		Grass Roots	
Metal	Frequency of Detection	Concentration (mg/kg)	Frequency of Detection	Concentration (mg/kg)
Aluminum	5/5	18 - 4950(1577)[a]	5/5	1680 - 10600(5146)
Arsenic	5/5	5 - 13(9.2)	4/5	<3[b] - 11(8.0)
Barium	5/5	2.6 - 12.5(6.0)	5/5	17.5 - 59.8(37.1)
Cadmium	0/5	<0.5	3/5	<0.5 - 0.9(0.7)
Fluoride	5/5	80 - 720(336)	4/5	15 - 620(152)
Lead	0/5	<3	4/5	<3 - 12(6.4)
Mercury	5/5	0.5 - 15.3(5.2)	5/5	0.6 - 67.1(15.3)
Silver	0/5	<0.5	0/5	<0.5
Sulfate	5/5	110 - 1300(1052)	5/5	80 - 1300(179)
Vanadium	1/5	<1 - 1(1.0)	4/5	<1 - 20(7.6)
Zinc	5/5	4.4 - 13.0(8.9)	5/5	8 - 115(44.4)

[a] ( ), arithmetic mean, includes detection limit when appropriate.
[b] Concentration less than stated detection limit.

the northeast corner of the production area and at Site 15, adjacent to the sewage treatment plant and former incinerator site. The organic chemicals anthracene, butylbenzyl phthalate, chrysene, fluoranthene, phenanthrene, pyrene, 2-nitrophenol, PCBs, chlordane, and DDT were analyzed for but not detected in FEMP vegetation.

RI/FS sampling also included agricultural crops and garden produce in the vicinity of the FEMP and at a reference area near Brookville, Indiana (Figure 3-59). This control area was chosen because it is upwind from the FEMP and has not been subject to deposition of airborne particulates from the FEMP. Uranium was detected at low concentrations in approximately a third of the samples from both the FEMP and reference areas (Table 4-91), with no differences in concentrations between the two sites. Cesium-137 was detected only at a low concentration in one field corn sample from Indiana, and strontium-90 in one alfalfa sample from the reference area (Table 4-91).

Eight mammal samples were collected from the FEMP during 1987-1988 and analyzed for isotopic uranium, cesium-137, and strontium-90. One sample, a composite of white-footed mouse and short-tailed shrew organs, had detectable uranium, at 18.0 pCi/g (Table 4-92). Cesium-137 and strontium-90 were not detected in mammal samples. Four samples were analyzed for the same inorganic and organic chemicals as in vegetation, except fluoride and sulfate. Aluminum, barium, mercury, and zinc were the only nonradioactive chemicals detected in mammals (Table 4-93).

Fish and benthic macroinvertebrates were collected from the Great Miami River, Paddys Run, and a small pond adjacent to Site 9B on the FEMP (Figure 3-61). Samples were analyzed for cesium-137, strontium-90, and isotopic uranium. Uranium was not detected in fish collected from the Great Miami River. As mentioned previously, most of the fish uranium values reported by NLO and WEMCO were also below the RI/FS detection limit of 0.6 pCi/g. The two data sets therefore appear to be similar in showing only low levels of uranium in fish from the Great Miami River. Uranium was detected in three of ten samples from Paddys Run, at a maximum concentration of 3.7 pCi/g, and in one sample from the FEMP pond at 1.7 pCi/g (Table 4-94). Uranium was detected in two of three macroinvertebrate samples from the Great Miami River and in four of five Paddys Run samples, with a maximum of 6.5 pCi/g total isotopic uranium in these organisms. Cesium-137 and strontium-90 were not detected in any samples of aquatic organisms. A single sample of minnows from Paddys Run was analyzed for nonradioactive constituents. Aluminum, arsenic, barium, cadmium, mercury, and zinc were detected in the sample, but organic constituents were not (Table 4-93).

TABLE 4-91
RADIONUCLIDE CONCENTRATIONS
IN GARDEN PRODUCE AND AGRICULTURAL CROPS
(RI/FS SAMPLING)

			Radionuclide Type and Concentration Range (pCi/g)		
Sample Type	Number of Samples	Location	Cesium-137	Strontium-90	Total Isotopic Uranium
Okra	1	Indiana	<0.4[a]	<0.5	<0.6
	3	FEMP vicinity	<0.3 - <0.5	<0.5	<0.6 - 2.2(1)[b]
Tomato	3	Indiana	<0.2 - <0.4	<0.5	<0.6 - 3.3(2)
	4	FEMP vicinity	<0.2 - <0.3	<0.5	<0.6 - 0.8(1)
Green pepper	2	Indiana	<0.3	<0.5	<0.6
	3	FEMP vicinity	<0.2	<0.5	<0.6 - 1.0(1)
Potato (flesh)	2	Indiana	<0.2	<0.5	<0.6
	1	FEMP vicinity	<0.2	<0.5	<0.6
Potato (peel)	2	Indiana	<0.2 - <0.3	<0.5	<0.6 - 2.7(1)
	1	FEMP vicinity	<0.2	<0.5	<0.6
Soybean	2	Indiana	<0.2	<0.5	<0.6
	1	FEMP vicinity	<0.2	<0.5	<0.6
Field corn	2	Indiana	<0.2 - <0.3(1)	<0.5	<0.6 - 2.1(1)
	2	FEMP vicinity	<0.2	<0.5	<0.6
Alfalfa	1	Indiana	<0.5	0.5(1)	4.1(1)
	1	FEMP vicinity	<0.4	<0.5	1.2(1)
Cucumber	1	FEMP vicinity	<1.1	<0.6	4.8(1)
Squash	1	FEMP vicinity	<0.3	<0.5	<0.6
Cabbage	1	FEMP vicinity	<0.2	<0.5	<0.6
Sweet potato	1	FEMP vicinity	<0.2	<0.5	<0.6
Pumpkin	2	FEMP vicinity	<0.3 - <0.4	<0.5	1.5 - 1.7(2)

[a] Concentration less than stated detection limit.

[b] Number of samples with detected radionuclide.

TABLE 4-92
RADIONUCLIDES IN MAMMAL TISSUE FROM THE FEMP (pCi/g)
(RI/FS SAMPLING)

Sample	Type	Site	Cesium-137	Strontium-90	Radionuclide Type Technetium-99[a]	Total Isotopic Uranium
Opossum	Muscle	North Pine Plantation	<0.2	<0.5	---	---
Opossum	Organs	North Pine Plantation	<0.2	<0.5	---	---
Opossum	Muscle[c]	---	<0.3	<0.5	<1.0	---
Cottontail	Muscle[c]	---	<0.7	<0.5	0.9	---
Small Mammal[b] (composite)	Carcasses	Waste Pit 5	<0.2	<0.1	---	---
Small Mammal[b] (composite)	Organs	Waste Pit 5	<1.1	<2.5	---	18.0
Small Mammal[b,c]	Carcasses	---	<0.2	<0.5	d	---
Deer	Kidney[c]	---	<0.2	<0.5	<0.9	---
Deer	Liver[c]	---	<0.2	<0.5	<0.9	---

[a] Technetium-99 analyzed for 1988 samples only.

[b] Composite small mammal samples of white-footed mouse and short-tailed shrew.

[c] 1988 samples.

[d] Insufficient sample for analysis.

TABLE 4-93
METAL CONCENTRATIONS IN WILDLIFE ON THE FEMP
(RI/FS SAMPLING)

Metal	Small Mammal Carcass Composite (mg/kg)	Cottontail Muscle (mg/kg)	White-tail Deer Kidney (mg/kg)	White-tail Deer Liver (mg/kg)	Minnows (mg/kg)
Aluminum	42.0	<4.0[a]	<4.0	8.0	6.0
Arsenic	13.0	8.0	17.0	20.0	28.0
Barium	1.0	<0.2	<0.2	<0.2	1.0
Cadmium	<0.5	<0.5	<0.5	<0.5	4.2
Lead	<3.0	<3.0	<3.0	<3.0	<3
Mercury	0.24	0.2	<0.1	<0.1	0.3
Silver	<0.5	<0.5	<0.5	<0.5	<0.5
Vanadium	<1.0	<1.0	<1.0	<1.0	<1.0
Zinc	38.3	10.9	32.3	33.2	51.8

[a] Concentration less than stated detection limit.

TABLE 4-94
RADIONUCLIDE CONCENTRATIONS IN AQUATIC ORGANISMS COLLECTED DURING RI/FS SAMPLING

Sample Type	Parameter	Cesium-137	Strontium-90	Total Isotopic[a] Uranium
Great Miami River Fish	Detection Frequency	0/16	0/15	0/15
	Range (pCi/g)	<0.2[c] - <0.7	<0.5	<0.6
	Average (pCi/g)[b]	0.26	0.5	0.6
Great Miami River Macroinvertebrates	Detection Frequency	0/3	0/3	2/3
	Range (pCi/g)	<0.2 - <2.1	<1.1 - <4.7	<0.6 - 6.5
	Average (pCi/g)	0.97	2.5	3.27
Paddys Run Fish	Detection Frequency	0/10	0/10	3/10
	Range (pCi/g)	<0.19 - <1.90	<0.5 - <3.32	<0.6 - 3.7
	Average (pCi/g)	0.52	0.80	1.02
Paddys Run Macroinvertebrates	Detection Frequency	0/5	0/5	4/5
	Range (pCi/g)	<0.2 - <4.0	<0.5 - <3.7	<0.6 - 6.4
	Average (pCi/g)	1.68	1.76	3.6
FEMP Pond Fish	Detection Frequency	0/3	0/3	1/3
	Range (pCi/g)	<0.2	<0.5	<0.6 - 1.7
	Average (pCi/g)	0.2	0.5	0.97

[a] Sum of U-234, U-235/236, and U-238. Complete data are provided in Appendix H.

[b] Arithmetic mean. Includes detection limit for samples below detection limits.

[c] Concentration less than stated detection limit.

4.1.7.3 Toxicity Tests

This section summarizes results of toxicity tests of FEMP effluent, soils, and sediments. Complete results of the RI/FS studies of these media are provided in Appendices E and F.

Acute and Chronic Testing of FEMP Effluent

FEMP effluent was tested for acute and chronic toxicity five times over a two year period from September 1988 to May 1990. No acute toxicity was detected in any of the *Daphnia pulex* or fathead minnow (*Pimephales promelas*) tests (Table 4-95). Chronic toxicity was detected in September 1988, June 1989, and January 1990 in the alga (*Selanastrum capricornutum*) test, and in September 1988 in the *Ceriodaphnia dubia* test. Algal growth was stimulated by FEMP effluent in the May 1989 and May 1990 tests. No chronic toxicity to fathead minnows was observed. The *Ceriodaphnia dubia* tests in May and June 1989 were invalidated due to unacceptable mortality in controls. These results are consistent with the acute toxicity tests of FEMP effluent conducted by OEPA (Webster et al. 1988), in which no mortality was observed in daphnids and fathead minnows exposed to undiluted effluent.

The uranium concentration in the effluent and NPDES permit-regulated effluent quality variables were recorded by WMCO during all toxicity testing periods (Table 4-96). No correlation was observed between uranium concentration or effluent quality variables and toxicity. Indeed, uranium in the effluent was highest during the May 1989 test period, when neither acute nor chronic toxicity was observed (Table 4-95).

Results of reference toxicant testing are detailed in Appendix E, Attachment III. All results agreed with either EPA established ranges (EPA, no date a,b) or the toxicology laboratory's database, indicating that organism responses to toxicants were consistent over the period of FEMP effluent testing.

Acute Toxicity Testing of Soils and Sediments at the FEMP

No statistically significant acute toxicity was observed in tests of soils and sediments collected from the FEMP. The low rad samples had consistently lower radionuclide concentrations than the high rad samples (Table 4-97), with the greatest difference in the uranium concentration, which exhibited a five-fold difference between soils and a ten-fold difference between sediments. Neither FEMP samples nor laboratory control sediment demonstrated any measurable acute toxicity to fathead minnows. At the end of 96 hours, the sediment from Site 1537 caused 10 percent mortality (Table 4-98), the highest mortality of the five substrates tested. However, this is within the EPA accepted variability allowed for natural mortality (Peltier and Weber 1985). A Student's t-test indicated no statistically significant difference in survival among any of the samples. Average length and wet weight of the fish in the various treatments were not statistically different.

At the end of the ten-day *Chironomus tentans* test, greater than 96 percent survival was observed

TABLE 4-95
SUMMARY OF EFFLUENT TOXICITY TEST RESULTS
LC_{50}, NOEC, AND LOEC PERCENT EFFLUENT FOR ALL TESTS[a]

	Testing Period				
Test Species and Endpoint	September 1988	May 1989	June 1989	January 1990	May 1990
Daphnia pulex LC_{50}	>100	>100	>100	>100	>100
Pimephales promelas LC_{50}	>100	>100	>100	>100	>100
Selenastrum capricornutum NOEC/LOEC	6.25/ 12.5	100/ >100[b]	<6.25/ 6.25	50/ 100	100/ >100[b]
Ceriodaphnia dubia NOEC/LOEC	12.5/ 25	[c]	[c]	100/ >100	100/ >100
Pimephales promelas NOEC/LOEC	100/ >100	100/ >100	100/ >100	100/ >100	100/ >100

[a] Values in table are percent effluent for the end point stated.

[b] Growth stimulated by effluent.

[c] Values invalidated due to excessive control mortality.

TABLE 4-96
EFFLUENT RADIATION AND DISCHARGE MONITORING DATA-MEAN MEASUREMENTS DURING EFFLUENT SAMPLING FOR TOXICITY[a]

Variable	Testing Period				
	September 1988	May 1989	June 1989	January 1990	May 1990
River Flow[b] (cfs)	447.03 (15.59)	7703.69 (2725.71)	6026.22 (3091.54)	3239.41 (2361.34)	9700.18 (7679.82)
Effluent Flow (cfs)	0.730 (0.410)	1.109 (0.115)	1.733 (0.390)	0.756 (0.213)	1.148 (0.541)
Total Alpha (pCi/ℓ)	1530 (1645)	774 (122)	295 (82)	622 (257)	342 (160)
Total Beta (pCi/ℓ)	722 (275)	552 (170)	193 (31)	256 (113)	79 (37)
Total Uranium (mg/ℓ)	0.70 (0.11)	1.76 (0.30)	0.49 (0.06)	0.94 (0.41)	0.62 (0.19)
Calculated Total U-238 (pCi/ℓ)	0.70 (0.11)	1.76 (0.30)	0.49 (0.06)	0.94 (0.41)	0.62 (0.19)
Total Residual Chlorine (mg/ℓ)	0.04[c]	0.08[c]	0.03[c]	0.03[c]	NA[d]
Nitrate (mg/ℓ)	1.3[c]	6.2[c]	2.4[c]	3.6[c]	2.8 (0.4)
Total Suspended Solids (mg/ℓ)	4[c]	26[c]	11[c]	7[c]	5 (1)
Ammonia (mg/ℓ)	NA[d]	0.22[c]	0.10[c]	0.35[c]	0.14 (0.01)
pH	8.1 (0.2)	8.2 (0.2)	8.0 (0.1)	8.1 (0.4)	8.2 (0.4)

[a] Values are arithmetic mean and standard deviation () for the effluent sampling dates in Table 3.1.7.3-

[b] (Mean flow at Hamilton gauge) x 1.0469. Multiplier calculated from Hamilton gauge data and flow rates at FEMP presented in IT (1988).

[c] Based on one measurement only

[d] NA, Not Available

SOURCE: WMCO (1990b)

TABLE 4-97
RADIONUCLIDE CONCENTRATIONS IN SOIL AND SEDIMENT SAMPLES TESTED FOR TOXICITY [a, b]

Sample	Cesium 137	Radium 226	Radium 228	Strontium 90	Thorium 228	Thorium 230	Thorium 232	Total Thorium	Uranium 234	Uranium 235/236	Uranium 238	Total Uranium
Low Rad Soil (1536)[c]	0.31	0.91	1.03	1.52	1.24	1.54	0.86	7.77	6.18	<0.6	6.32	20.7
High Rad Soil (1535)	0.41	1.09	1.34	3.44	1.40	4.92	1.32	11.9	30.9	1.51	32.4	115
Low Rad Sediment (1538)	<0.2	0.53	<0.5	<0.5	0.28	0.63	0.18	3.34	<0.6	<0.6	<0.6	1.81
High Rad Sediment (1537)	<0.2	0.90	0.70	1.30	1.07	2.41	0.62	5.57	5.25	0.760	5.93	20.3

[a] Concentrations in pCi/g dry weight, except for total thorium and total uranium, both µg/g.

[b] Concentrations of ruthenium-106, neptunium-237, plutonium-238, plutonium-239/240, and technetium-99 were below detection limits in all samples.

[c] Sample number.

TABLE 4-98

SUMMARY DATA FOR 96-HOUR PIMEPHALES PROMELAS SOLID PHASE TOXICITY TEST

Sample	Survival[a] (Percent)		Length[b] (mm)		Weight[b] (g)	
	Mean[c]	SD[d]	Mean[c]	SD	Mean[c]	SD
Control	97.0	5.25	14.1	1.17	0.0222	0.0089
Low Rad Soil (1536)[e]	96.7	5.77	14.3	1.41	0.0289	0.0064
High Rad Soil (1535)	93.3	5.77	14.7	1.87	0.0266	0.0121
Low Rad Sediment (1538)	96.7	5.77	13.6	1.24	0.0276	0.0106
High Rad Sediment (1537)	90.0	10.00	14.6	0.88	0.0375	0.0068

[a] Sample size equals 3.

[b] Sample size equals 9 (3 fish in each of 3 replicates).

[c] Arithmetic mean.

[d] SD, standard deviation.

[e] Sample number.

(Table 4-99). There were no significant differences in survival between low rad and high rad samples. Therefore, the sediments and soils are reported to be not acutely toxic to Chironomus tentans.

The only mortality observed during the 48-hour Daphnia magna elutriate bioassay was one organism in one chamber containing the 100 percent elutriate from the low rad sediment sample. The reported LC_{50} for all samples was, therefore, greater than 100 percent elutriate and no sample showed acute toxicity to daphnids.

Results of reference toxicant testing are detailed in Appendix F. All results agreed with either EPA established ranges (EPA, no date a,b) or the toxicology laboratory's database, indicating that organism responses to toxicants were consistent over the period of testing.

TABLE 4-99
SURVIVAL DATA FOR CHIRONOMUS TENTANS SOLID PHASE TOXICITY TEST

	Survival (%)	
Sample	Mean[a]	SD[b]
Control	100.0	0.00
Reference Soil (1536)	98.3	2.89
Site Soil (1535)	98.3	2.89
Reference Sediment (1538)	96.7	2.89
Site Sediment (1537)	100.0	0.00

[a] Sample size equals 3.

[b] SD, standard deviation.

4.2 Completed Removal Actions

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4.2 CHANGES RESULTING FROM COMPLETED REMOVAL ACTIONS

The scope of the SWCR includes a description of the effects of any FEMP removal action completed as of December 1, 1991, the data cutoff date for this document. Removal actions completed or ongoing at the FEMP are described in Section 1.2.2. As described in Section 1.2.2, the only removal action which was complete as of December 1, 1991 and for which monitoring data was available was the addition of bentonite to Silos 1 and 2 to control the emission of radon (DOE 1990). The effects of this action on radon emissions are described below.

Silos 1 and 2 are concrete structures containing approximately 9700 tons of K-65 residues from past DOE operations, including remains from pitchblende processing that occurred about 50 years ago. Initial sampling during 1989 indicated concentrations of radium ranging from 657 to 193,000 pCi/g residue (Section 4.1.1). Radon is a gaseous decay product of radium, and available data has suggested that contamination originating from the Silos 1 and 2 may pose a risk to human health and the environment. Accordingly, the Consent Agreement required a removal action (DOE 1990) for the silos to provide current protection to the public while the RI for OU4 is being conducted.

During November, 1991, the K-65 residues were covered with a layer of bentonite, a moist, clay-like material that acts as an impediment, hindering the flow of radon from the residues beneath. The general extent to which the bentonite cover has reduced radon concentrations in ambient air can be assessed by comparing the "before" and "after" data presented in Tables 4-100 and 4-101. Both tables are based on hourly, real-time monitoring data recorded by the FEMP.

Table 4-100 is based on data recorded at the four on-site monitor locations having the highest radon concentrations prior to the installation of bentonite. (The four locations are near the K-65 exclusion fenceline, as shown in the inset on Figure 3-5). The "before" data in Table 4-100 includes all data recorded during the month of October, 1991, whereas the "after" data includes all data recorded during December, 1991. All "before" and "after" data include background concentrations. Table 4-101 is a similar table based on data recorded at the four perimeter air monitoring stations located nearest to Silos 1 and 2. Accordingly, the two tables depict the highest on-site concentrations and highest off-site concentrations, respectively. These data indicate that radon emissions from the silos have been reduced by over 95 percent.

TABLE 4-100
HIGHEST ON-SITE RADON CONCENTRATIONS BEFORE AND AFTER BENTONITE PLACEMENT IN K-65 SILOS[a]

	Four On-Site Monitor Locations Having Highest Concentrations											
	NW		SW		NE		SE		All Four[b]		Background	
	Before	After	Before	After	Before	After	Before	After	Before	After	Before	After
Number of Readings	560	725	647	723	731	728	370	728	2308	2904	741	741
Maximum Concen., pCi/l	81	9	150	27	215	7	241	25	241	27	3	4
Minimum Concen., pCi/l	0.2	0.1	0.4	0.1	0.2	0.1	0.4	0.1	0.2	0.1	0.1	0.2
Average Concen., pCi/l[c]	6.49	0.99	8.52	1.34	15.16	1.19	21.54	1.37	12.22	1.22	0.86	0.63
Standard Deviation	9.17	1.00	14.53	1.63	25.16	1.06	40.32	1.94	23.85	1.47	0.48	0.38
95% Confidence Interval[d]	±0.76	±0.07	±1.12	±0.12	±1.82	±0.08	±4.11	±0.14	±0.97	±0.05	±0.03	±0.03

[a]This table, based on monitoring data recorded by the FEMP, presents results of hourly real-time monitored concentrations at four locations near the K-65 exclusion fenceline and at a remote (background) location. The "before" data consist of hourly concentrations recorded at each location during the month of October, 1991, before installation of the bentonite. The "after" data consist of concentrations recorded at each location during December, 1991. All "before" and "after" data include background concentrations.
[b]Combined data from NW, SW, NE, and SE monitors.
[c]DOE guideline concentration for the general public is 3.0 picoCuries per liter (pCi/l) above-background, as stated in DOE Order 5400.5, February, 1990.
[d]The values in this row are plus-or-minus ranges from the average. For example, at the 95% confidence interval the average concentration of the 2,308 readings taken prior to bentonite installation is 12.22 ±0.97 pCi/l, and the average of the 2904 readings taken after installation is 1.22 ± 0.05 pCi/l. Both include background levels of approximately 0.6 pCi/l.

TABLE 4-101

HIGHEST OFF-SITE RADON CONCENTRATIONS BEFORE AND AFTER BENTONITE PLACEMENT IN K-65 SILOS[a]

	Four Fenceline Monitor Locations Nearest the K-65 Silos											
	AMS 1		AMS 5		AMS 6		AMS 7		All Four[b]		Background	
	Before	After	Before	After	Before	After	Before	After	Before	After	Before	After
Number of Readings	676	735	642	740	733	732	664	737	2715	2944	741	741
Maximum Concen., pCi/l	3.2	7.0	5.9	5.0	4.7	6.0	6.1	6.0	6.1	7.0	2.7	4.0
Minimum Concen., pCi/l	0.2	0.2	0.1	0.1	0.2	0.2	0.2	0.2	0.1	0.1	0.1	0.2
Average Concen., pCi/l[c]	0.81	0.70	1.39	0.61	1.2	0.61	1.59	0.62	1.24	0.64	0.86	0.63
Standard Deviation	0.49	0.70	1.17	0.54	0.91	0.47	1.34	0.60	1.06	0.58	0.48	0.38
95% Confidence Interval[d]	±0.04	±0.05	±0.09	±0.04	±0.07	±0.03	±0.10	±0.04	±0.04	±0.02	±0.03	±0.03

[a]This table, based on monitoring data recorded by the FEMP, presents results of hourly real-time monitored concentrations at four locations along the FEMP property fenceline (Figure 3-4) and at a remote (background) location. The "before" data consist of hourly concentrations recorded at each location during the month of October, 1991, before installation of the bentonite. The "after" data consist of concentrations recorded at each location during December, 1991. All "before" and "after" data include background concentrations.
[b]Combined data from AMS 1, AMS 5, AMS 6, and AMS 7 monitors.
[c]DOE guideline concentration for the general public is 3.0 picoCuries per liter (pCi/l) above-background, as stated in DOE Order 5400.5, February, 1990.
[d]The values in this row are plus-or-minus ranges from the average. For example, at the 95% confidence interval the average concentration of the 2,715 readings taken prior to bentonite installation is 1.24 ±0.04 pCi/l, and the average of the 2944 readings taken after installation is 0.64 ±0.02 pCi/l. Both include background levels of approximately 0.6 pCi/l.

4.3 Data Validation

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4.3 DATA VALIDATION

According to the terms of the Amended Consent Agreement, the SWCR is a secondary document and will not be used to make decisions about the need for or choice of remedial actions at the FEMP. The usability of the data presented is therefore not addressed in this document. RI/FS data presented in operable unit RI reports, which will serve as the basis for remedial action decision-making, will be fully validated. Data validation for the FEMP RI/FS was not complete as of December 1, 1991, when it was necessary to begin compiling data summaries for the SWCR. However, the section below describes the data validation process for the RI/FS and provides a general status of the program at the time of preparation of the SWCR.

4.3.1 Introduction

Data validation is an after-the -fact, independent, systematic process of evaluating data and comparing it to pre-established criteria to provide confirmation that the data is of the technical quality necessary to meet the intended use, and to assure that a legally defensible "road map" can be established that traces the sample from the time it is collected in the field to the ultimate end use. The process of validation by trained and experienced personnel in the chemical and radiological fields is the fundamental basis for determining the quality and usefulness of data on which to support technical decisions. Validation reviews specific parameters associated with the data to determine whether it meets the data quality objectives (DQOs) stipulated. The quality objectives address five principal parameters: precision, accuracy, completeness, comparability and representativeness. To verify that these objectives are met, the validation process examines field measurements; sampling and handling procedures; laboratory analysis and reporting; and evaluation of nonconformances and discrepancies in the data to determine compliance with appropriate and applicable procedures. Data qualifiers are assigned to the analytical data to alert the user of any nonconformances to quality assurance/quality control (QA/QC) requirements.

The level of quality required depends on the intended use of the data, which in turn dictates the appropriate level or extent of validation. The FEMP RI/FS Data Validation Plan classifies data into one of five analytical support levels (ASLs):

- ASL I (qualitative) - Applies to field screening or analysis using portable instruments. Results are often not compound-specific and not quantitative, but are available in real time.

- ASL II (semi-quantitative) - includes both field and laboratory analyses using either more sophisticated portable analytical field instruments or controlled laboratory procedures. Results are defendable as approximations of the true values of measured analytes.

- ASL III (quantitative) - includes all analyses performed in an off-site laboratory which may or may not use EPA Contract Laboratory (CLP) procedures, providing quantitative results within the limits of the laboratory quality assurance plan. Actual defendability of data is uncertain due to the absence of supporting raw data to determine actual compliance with established QA/QC requirements.

- ASL IV (quantitative) - EPA CLP routine analytical services. All analyses are performed at an off-site analytical laboratory approved to perform analyses under the EPA Contract Laboratory Program using specified CLP protocols. This level is characterized by rigorous QA/QC procedures and documentation. The majority of the chemical analyses performed for compounds on the HSL were performed under the 1988 EPA CLP Statement of Work.

- ASL V (quantitative) - analysis by non-standard methods. All analyses are performed at an off-site laboratory which may or may not be a CLP laboratory. Standard methods are those which have been accepted and/or published by EPA. Radiological and dioxin/furan analyses fall into this category. Other data collected for ASL III or IV are sometimes assigned instead to ASL V because of method modifications or departures noted during reviews. Data derived from non-standard methods are subject to the same QA/QC requirements as ASL III data and require additional internal validation of the method by the laboratory.

After the data validation process, a technical evaluation is performed by OU personnel to assess its technical usefulness for their specific needs.

4.3.2 Validation Process and Procedures

The validation program is divided into two phases. The first phase considers field data and is validated to ASL I or II only. The second phase deals with analytical chemical and radiological results, and is validated to ASL III, IV or V. For most of the chemical data, reviews are performed under the CLP Statement of Work, corresponding to ASL IV. Data reported under a Certificate of Analysis (C/A) are reviewed and qualified as ASL III. Separate evaluations are conducted for organic and inorganic analyses included in the HSL. The HSL list includes 24 metals and cyanide in the inorganics section. Organics include 35 volatiles, 65 semi-volatiles, and 27 pesticides and PCBs. Specific EPA-approved methodologies for radiological analyses do not presently exist, nor does the EPA, DOE, and the NRC have in place guidelines for radiological data validation. Specific methodologies and requirements for radiological validation are not presented in the QAPP. The radiological analyses are performed according to the standard operating procedures and QA plan of the laboratory. Consequently, an evaluation and verification of the laboratory procedures and QA program was necessary.

The key criteria reviewed in the field and analytical validation process are as follows:

Field

- field daily activity logs
- sample collection log
- specific field forms for sample collection and handling
- chain of custody
- request for analysis
- field instrument calibrations
- field personnel training
- variances
- surveillances of field activities

Chemical

Organics

- holding times
- GC/MS tune (BFB,DFTPP)
- GC/MS calibration
- surrogate recoveries
- matrix spikes/ matrix spike duplicates
- blanks
- internal standards

Inorganics

- holding times
- ICP/GFAA instrument performance checks
- initial and continuing calibrations
- matrix spikes/ matrix spike duplicates
- blanks

Radiological

- traffic reports
- holding times
- duplicate precision
- laboratory control samples
- blanks
- detection limits
- matrix spikes
- uranium isotopic ratios

4.3.2.1 Review of Field Data

Validation checklists are used to trace a particular sample from one document to another, and relate information contained on boring logs, sample collection logs, chain of custody (CoC) and request for analysis (RFA) forms, the field activity daily logs (FADLs) and geologist field logs. Information is checked to determine if all requirements of the FEMP RI/FS QAPP were implemented as the documents were prepared. Field forms are checked for completeness, and calibration documentation is verified for each field instrument used or analysis performed. Training records are checked to ensure that all field personnel have current, and complete training as required by specific work plans.

4.3.2.2 Review of Chemical Data

Separate reviews are performed for organics and inorganics analyses reported under the EPA CLP format for substances included in the HSL. Analyses for non-HSL compounds such as general chemistry, TCLP, groundwater monitoring, etc. were performed under Certificates of Analyses. Samples were reviewed based on QC results reported with the data. Some analytes such as Appendix-IX, and dioxins/furans were reported in a CLP-equivalent format, and were reviewed based on the information provided.

4.3.2.3 Organics Review

For data reviewed, the organics portions are divided into three sets of volumes, volatiles (VOA), semi-volatiles (BNA) and pesticides/PCBs (PEST/PCB). Each volume contains the sample results, a summary of QC data, calibration data, and supporting raw data for an entire set of results. A sample data summary is also included which includes copies of sample results, QC results, and QC summaries. Also included are the C/As and supporting documents such as CoC forms and RFAs.

The review consists of documentation of compliance, or deviation from expected QC limits established for sample holding times, GC/Mass-spectrometer performance (i.e. tuning), GC/MS calibration, surrogate spike recoveries, matrix spike recoveries, matrix spike duplicates, blank contaminants, and internal standard performance. In addition, system performance for PEST/PCB analysis is documented by checking linearity of analyte response, absolute retention times for DDT, potential for break down of DDT and endrin on the GC column, retention time shifts relating to identification, and determining that observed retention times for standards and samples fall within defined limits.

Holding Times

Sample collection and receipt dates are determined from the CoC forms included in the package. The RFA is checked to determine if all sample data was reported in the CLP deliverables. The holding times are then calculated for VOA, VOA aromatics, BNA extractions and analysis, and PEST/PCB extractions and analysis. Compliance with either 40CFR136, or SW-846 holding times is determined and each variance, or deficiency is documented for subsequent evaluation.

GC/MS Tune

For GC/MS data to be valid as related to identification of unknown compounds present in a sample, it must be demonstrated that the "mass-range" in which the instrument is working is consistently calibrated or "tuned". Tune summaries are provided for each 12-hour period during which samples or standards are analyzed. These summaries and raw data are checked to verify that the GC/MS is re-tuned each 12-hour period as required and that the relative abundances of masses obtained from the injected materials fall within defined ranges.

GC/MS Calibration

The quantitative performance of the GC/MS system is demonstrated by analyzing a series of standards to determine linearity and response. An initial calibration is made based on 5 concentrations, for which a response factor (RF), and a relative deviation (RSD) are determined. When criteria are met for certain compounds the calibration is accepted provided performance criteria are met on a daily basis for a single-point calibration. From this "continuing" calibration, an RF and a percent difference (%D) is calculated. Again, specific compounds are targeted to determine acceptance of the daily, or continuing, calibration. The review consists of determining RF, RSD, %D for each analyte, and verifying compliance of target compounds relating to acceptability of calibration.

Surrogate Recoveries

Sample extraction and dilution accuracy is determined by checking surrogate recovery performance for VOA, BNA and Pest/PCB analysis. Surrogates are non-target analytes which mimic the chemical characteristics of target analytes and are added to the sample during preparation.
Recovery results are reported for each sample, sample dilution, or QC sample analyzed (QC samples include blanks, matrix spike, matrix spike duplicate). Surrogate recovery data are used to determine if reported results are subject to either positive or negative bias. Deviations from expected surrogate recoveries are documented in the review for further evaluation.

Matrix Spike/Matrix Spike Duplicates

Under the CLP protocol for organics, matrix spikes are performed in duplicate to monitor long term precision and accuracy. Target analytes are "spiked" into the sample and are analyzed in duplicate. The %R are calculated and the relative difference between duplicates (RPDs) determined. Results obtained are compared with expected recovery and precision ranges and are documented.

Blanks

Daily calibration and prep blanks are performed for each analytical method and are reported in the CLP deliverables. Blank data are examined for both target and non-target analytes. Analytes found present in the blank sample above the instrument detection limit are documented for further evaluation.

Internal Standards

Internal Standards are non-target analytes added to the sample at preparation, similar to surrogates, which are used as references for calibration of specific analytes by GM/MS. These are used to adjust for variations in operational parameters for VOA and BNA analysis, and are added to all samples and QC samples. Standard area counts which are outside specified limits are documented for further evaluation.

4.3.2.4 Inorganics Review

Inorganics data are contained in a single set of volumes. This volume contains the sample results, a summary of QC data, calibration data, and supporting raw data. The sample data summary, a part of the complete set of CLP deliverables, includes the Case Narrative and supporting documents such as CoC forms and RFAs.

The inorganics review consists of documentation of compliance, or deviation from expected QC limits established for sample holding times, ICP, GFAA and other instrument performance criteria, initial and continuing calibrations, matrix spike recoveries, matrix spike duplicates, blank contaminants, detection limit determinations and serial dilution studies.

Holding Times

Sample collection and receipt dates are determined from the CoC forms included in the package. The RFA is checked to determine if all sample data was reported in the CLP deliverables. The holding times are then calculated for metals, mercury, and cyanide. Compliance with either 40CFR136 or SW-846 holding times is determined and each variance or deficiency is documented for subsequent evaluation.

ICP/GFAA/Instrument Performance

Metals analyses are performed by either inductively coupled plasma (ICP) spectroscopy, or graphite furnace atomic absorption (GFAA) analysis. For ICP, instrument performance is documented by analyzing an interference check sample during every work period. These are examined to assess the potential for falsely identifying, or quantitating the analytes found in respective samples. Duplicate injections, and calibration data are used to assess the performance of the GFAA.

Initial and Continuing Calibrations

The quantitative performance of the ICP or GFAA is demonstrated by analyzing a series of standards to determine linearly and response. Initial calibrations are made based on multi-point calibrations, which include at least one blank and one standard. When criteria are met for the initial calibration, samples may be analyzed provided that continuing performance criteria are met. The review consists of determining RF, RSD, %D for each analyte, and verifying compliance of target compounds relating to acceptability of calibration.

Matrix Spike/Matrix Spike Duplicates

Under the CLP protocol for inorganics, matrix spikes are performed in duplicate to monitor long term precision and accuracy. Target analytes are "spiked" into the sample and are analyzed in duplicate. The %R are calculated and the RPDs determined. Results obtained are compared with expected recovery and precision ranges and are documented.

Blanks

Daily calibration and prep blanks are performed for each analytical method and are reported in the CLP deliverables. Blank data are examined for both target and non-target analytes. Analytes found present in the blank sample above the instrument detection limit are documented for further evaluation.

4.3.2.5 Radiological Review

The radiological data package consists of the sample traffic reports (COC and RFA), sample results, supporting raw data, and QC data. The packages do not contain information on sample preparation or instrument calibration, and until mid-1991, did not contain C/As. The validation process consists of reviewing the documentation for completeness, consistency and compliance with established QC criteria and other specific parameters listed above. Any discrepancies, deficiencies and/or variances are noted and appropriate actions are taken. Radiological data is qualified to either ASL V or ASL II.

Sample Holding Times

There are no established hold time criteria for radiological samples and long-lived radionuclides can be held indefinitely if properly preserved and stored to prevent cross-contamination. However, samples held longer than six months prior to analyses are noted for future evaluation. There is no action required if hold times are missed.

Sample Preparation and Instrument Calibration

Although this information is not included in the data package, and therefore not reviewed for each sample delivery group, periodic audits of the laboratory are conducted to determine if laboratory QA/QC procedures are being followed and instrument calibration is properly documented.

Detection Limits

The detection limit is an estimate of the activity concentration that is practically measurable by a specific instrument, measurement method, and type of sample analyzed. Results reported as "less than" values, and which are over the Contract Required Detection Limit (CRDL) stipulated in the QAPP and Data Validation Program appendix to the QAPP, are qualified as R, or unusable. There is a high probability that these sample results are false negatives.

Quality Control Samples

Duplicates and matrix spikes are performed a minimum of 1 out of every 20 samples to determine the precision and accuracy of the analytical and counting methods. Laboratory control samples or spikes, which are spiked distilled water samples, are internal QC samples performed as an additional monitor of accuracy for both aqueous and solid samples. Recovery deviations from the acceptable range, as stipulated in the QAPP, are documented and appropriate qualifiers are assigned according to the degree of departure from the accepted values. At least one method blank is analyzed per 20 samples to detect any contamination from target and non-target radionuclides. Radionuclides that are present in the samples and in the blanks above the CRDL are noted and evaluated.

Uranium Isotopic Ratios

The consistency of total and isotopic uranium data are reviewed to determine if there are any anomalies in the data that should be investigated further, such as the percent enrichment by mass of U-235. Any discrepancies are documented for further evaluation.

4.3.3 Problems Encountered

4.3.3.1 Field Problems Encountered

Problems encountered with field validation concern completeness of records, and discrepancies between forms. An incidence rate of approximately 20% of samples are affected. Records for these samples are resubmitted to originators for completion and/or correction. Where discrepancies or missing field data cannot be resolved, a field validation qualifier is assigned to alert the user that sample representativeness may not be documentable. When this condition exists, subsequent laboratory analysis, no matter how accurate or precise, will not improve the defendability of data.

Field QC data such as field duplicates, field and trip blanks, rinseate blanks, etc. were not evaluated as a group to assess the overall performance of the field collection program. When identified, field QC samples were included in the review process for laboratory data.

4.3.3.2 Organics

The majority of problems encountered for organics related to missed hold times, calibration deficiencies, matrix interferences, or contamination of laboratory blanks. Affected data was qualified according to the FEMP RI/FS Data Validation Plan.

Holding Times

Holding times were missed on approximately 5-10% of samples collected for organics analyses. These affected all analyte groups with varying frequencies. Most often affected were volatile aromatics contained in the VOA fraction. Volatile aromatics have a seven day hold time when not preserved with HCl to pH<2.0. The high frequency of missed holding times is partially related to the fact that samples collected are "mixed-waste" and often require additional handling during analysis. Holding

times were usually exceeded by only a few days, but in several instances were for extended periods of time. Validation qualifiers were added to affected data.

Calibrations

Deficiencies involving instrument calibrations were responsible for the greatest number of qualifications on data. The HSL list contains several organic compounds which are very difficult to analyze for due to their high solubilities in water. The compounds listed below were found to exceed expected calibration ranges most frequently. Data is affected by a decrease in the precision and/or accuracy of reported results. Qualifiers were added to reported results to identify the uncertainties observed.

Volatiles

chloromethane, bromomethane, methylene chloride, acetone, 1,1-dichloroethene, trans-1,2-dichloroethene, 1,2-dichloroethane, 2-butanone, vinyl acetate, cis-1,3-dichloropropene, trans-1,2-dichloropropene, 4-methyl-2-pentanone, 2-hexanone, 1,1,2,2-tetrachloroethane

Semi-Volatiles

benzyl alcohol, bis-(2-chloroisopropyl)ether, benzoic acid, 4-chloroaniline, hexachlorocyclopentadiene, 2-nitroaniline, 3-nitroaniline, 2,4-dinitrophenol, 4-nitrophenol, 2,4-dinitrotoluene, 4,6-dinitro-2-methylphenol, pyrene, benzo(k)fluoranthene, benzo(a)pyrene, indeno(1,2,3,c,d)pyrene, dibenzo(a,h)anthracene

Matrix Spikes/Duplicates

From the review of data, it was noted that several of the matrices sampled contained matrix interferences which affected laboratory analysis. The problems encountered resulted in deficiencies related to precision and accuracy. In most instances, deficiencies resulted in low spike recoveries or high percent deviations for duplicate analyses. Where these matrices are encountered, all reported data should be considered imprecise and potentially biased low. Reported non-detects may be false negatives, and may not be indicative of actual conditions in the field. Validation qualifiers were added to reported results to address the biases observed.

Blank Contaminants

Blank contaminants were noted with the most frequency in the volatiles fraction. These included methylene chloride, acetone, 2-hexanone, and 2-butanone. Toluene and xylenes were also noted in blanks, but at a lower incidence. Blanks for semi-volatiles analyses occasionally contained phthalate esters which are also common laboratory contaminants. The presence of laboratory blank contaminants affect data by increasing the probability that false positives will be reported in sample

results. The presence of both sample and/or laboratory sources of target analytes makes quantitation of collected samples more uncertain. Validation qualifiers were added to affected data to alert the user to these problems.

4.3.3.3 Inorganics

The deficiencies encountered with the most frequency for inorganics include missed hold times, low spike recoveries, serial dilution problems and contaminants in laboratory prep blanks. Affected data were qualified according to the FEMP RI/FS Data Validation Plan.

Holding Times

Holding times were rarely met for hexavalent chromium and nitrate which have holding times of 24 and 48 hours, respectively. These requirements could not be met due to the additional transportation and screening processes associated with the analysis of "mixed-waste". Reported values for these materials should be considered as estimates whenever encountered in the data. Values reported for total chromium should be taken into consideration when evaluating results for hexavalent chromium. Occasionally, hold times were missed for mercury and cyanide. Validation qualifiers were added to all affected data.

Spike Recoveries

Low spike recoveries were encountered frequently for heavy metals such as selenium, lead, and antimony. These metals often had spike recoveries of less than 30% creating a potential for false negatives in reported data for these elements. Arsenic and thallium also exhibited low spike recoveries from time to time. Validation qualifiers were added to affected data.

Serial Dilutions

Serial dilutions performed for beryllium, cadmium, copper, chromium, and vanadium during analysis to evaluate the effects of matrix interferences frequently did not match undiluted sample results. The effect on data is a decrease in the accuracy and/or precision of the reported results. Validation qualifiers were added to reported data where this deficiency was noted.

Blank Contaminants

There were very few blank contaminants observed in the inorganics data. Occasional contaminants included beryllium, copper, zinc, sodium, silver, nitrate, molybdenum, and TKN. The presence of laboratory blank contaminants affects data by increasing the probability that false positives will be reported in sample results. The presence of both sample and/or laboratory sources of target analytes makes quantitation of collected samples more uncertain. Validation qualifiers were added to affected data to alert the user to these problems.

Radiological Problems Encountered

As of October 1991, approximately 9000 samples had been collected over the past 4 to 5 years for radionuclide analysis. However, there did not exist a program for radiological validation, due to the lack of qualified personnel to develop validation guidelines and procedures, and the fact that all the radiological data records and associated QC data were not stored at the laboratory facility in an easily retrievable form. A previous effort to validate radiological data in late 1990 was unsuccessful due to this problem. In addition, C/As were either not present in the packages, or were inadequate in that they did not address deviations in the QC. In the summer of 1991, ASI requested the laboratory to reorganize their records so that the data package includes the applicable QC documentation. Although the data packages were reorganized, many of them had problems. They were not consistent in structure, analytical analyses and QC performed, and reporting format, thus making it difficult to validate. Despite the apparent problems with the data packages, validation of the approximately 9000 back-logged radiological samples was 100% complete by the end of 1991. Validation Deficiency Reports have been generated for approximately 70% of them.

4.3.4 Status of Validation

The status of field validation is presented in Table 4-102, and lists the numbers of samples collected for various tasks, the numbers of samples analyzed, and the field validation status.

The status of radiological and chemical validation is presented in Table 4-103. The table lists by analyte group, the number of samples submitted for validation for OU2, OU4, OU1, and other tasks. As of this date, all samples identified to the OU1 task have been reviewed and qualified. Validation deficiency reports are pending for most of the chemical samples, and 30% of the radiological samples. Deficiency reports are also pending for approximately 30% of rad samples identified to other tasks.

As of March 20, 1992, a total of 7,262 samples have been submitted to the laboratory for analysis. To date, validation has been completed for 3,503 chemical analyses (i.e. volatiles, semi-volatiles, metals, etc.), and 5,678 radiological samples.

4.3.4.1 Summary of RI/FS Data

Deficiency reports are written for all chemical and radiological sample data sets that have been reviewed. These identify the problems observed, and describe the potential effects on data. Non-flagged data may be used for any purpose, and appear to be both scientifically and legally defendable as required by the FEMP RI/FS Quality Assurance Plan. Data flagged with a (J) qualifier may be assumed to be present, but are not within "quantitative" limits anticipated by the QA plan. Data qualified as (J) may be biased either high or low, or may be imprecise and should be considered as estimated values.

Data which are observed at levels less than the corresponding limit of detection are qualified as "U,"

TABLE 4-102

SAMPLES COLLECTED FIELD VALIDATED AS OF MARCH 24, 1992

WBS #	Task Name (Old Task #)	Samples Collected[a]	Samples Analyzed[b]	Samples Validated	Percent Complete	Scheduled Completion
	Surface Soil (3.2)	3581	435	435	100%	Complete
	Groundwater (3.2.4)	1650	1234	1234	100%	Complete
50.03.02	31-Well Program (3.10)	96	54	54	100%	Complete
50.03.03	Paddys Run (3.11)	136	136	136	100%	Complete
50.03.04	8 RCRA Wells (3.12)	9	9	9	100%	Complete
20.03.01	OU 1 (3.15)	505	202	202	100%	Complete
20.03.01	OU 2 (3.16)	370	289	289	100%	Complete
20.03.02	OU 2 Rework (3.16)	24	24	24	100%	Complete
40.03.01	Slant Borings (3.19)	190	96	96	100%	Complete
40.03.02	Vertical Borings (3.20)	259	152	152	100%	Complete
40.03.03	Content Sampling (3.21)	492	452	452	100%	Complete
03.01.01	EWMF (3.22)	639	157	139	89%	Awaiting Data
50.03.08	Misc. Additional Wells (3.23)	-	-	-	-	In Progress
04.13	Coal Pile Run Off (3.24)	94	15	15	100%	Complete
04.01	Hand Aug Waste Pits (3.25)	284	126	126	100%	Complete
04.09	Decant Sump (3.26)	9	9	9	100%	Complete
04.04	Hand Aug Plant 1 Pad (3.27)	157	71	71	100%	Complete
04.06	Perched Water Rem Act (3.29)	26	26	26	100%	Complete
	Surface Water (3.3)	291	291	291	100%	Complete
50.03	RCRA Metals Background (3.34)	-	-	-	-	In Progress
04.08	Plant 8 Core Sampling (3.35)	101	101	101	100%	Complete
04.17	Integrated Demo Pjct (3.40)	39	39	39	100%	WEMCO
	Surface Soil (3.4.2)	1126	650	650	100%	Complete
	Ecological (3.5)	349	289	289	100%	Complete
50.03.01	Facilities Testing (3.7)	10802	1982	1982	100%	Complete
	Bldg 69 Invest (3.8)	273	189	189	100%	Complete
	WEMCO RCRA Groundwater (9.18)	100	100	100	100%	Complete
	9.27	134	134	134	100%	Complete

[a] Includes Archive, Geotechnical, Treatability, and Analytical samples
[b] Includes Geotechnical, Treatability, and Analytical samples

TABLE 4-103
LABORATORY SAMPLES VALIDATED
AS OF MARCH 20, 1992

	OU 2	OU 4	OU 1	Other Tasks	Total	Total % Complete D
Inorganics	149	240	233	868	1490	84%
Volatiles	100	174	95	381	750	87%
Semi-Volatiles	123	94	52	305	574	91%
Pest/PCBs	123	35	58	334	550	89%
OP/Pest	17	--	5	--	22	77%
App IX	17	--	33	--	50	34%
Dioxins	--	--	1	39	40	97%
Herbicides	17	--	10	--	27	63%
Radiological	231	253	532	4662	5678	72%
Totals	777	796	1019	6589	9181	72%

or not detected above the associated value. This qualifier is usually assigned to data by the laboratory, but is also used as a validation qualifier. When used as a validation qualifier, "U" indicates that the analyte is not considered present because of blank interferences. Some of the early data was flagged with a "JB" qualifier indicating potential bias from blank contamination. This qualifier is no longer used, and is replaced with either the "J" or "U" qualifier. In instances where the limit of quantitation is uncertain, data flagged by the laboratory as "U," not detected, are qualified as estimated, "UJ". Additional qualifiers for radiological data are "D," "C," "E," and "F." A "D" qualifier indicates a possible false negative which is a reported non-positive result greater than the detection limit for that radionuclide. The qualifiers "C," "E," and "F" refer to the uranium results. A "C" qualifier, assigned to uranium-238, indicates that the calculated total uranium value from the measured isotopic results does not agree within 20 percent of the measured total uranium result. An "E" qualifier, assigned to uranium-235, indicates that the calculated percent enrichment of uranium-235 is outside of the acceptance limits of 0.2 to 1.3 percent. An "F" qualifier, assigned to uranium-234, indicates that the U-234/U-238 ratio is outside of the acceptance limits of 0.4 to 1.3 percent. It is possible that multiple qualifiers are assigned to an analyte. For example, uranium-238 can be assigned a "CJ" or a "DCJ."

Data flagged with an (R) were determined to be unusable for general uses. Data was flagged as (R) unusable whenever holding times were grossly exceeded, or when severe QC deficiencies were observed. Data of this nature may not be suitable for all purposes and should be reviewed by the user prior to use to determine useability for a particular purpose.

4.3.5 Review of Weston (1987) Data

The following summary describes the current status of the Weston (1987) data, and provides a position related to potential use(s) as a result of validation. Weston (1987)a includes samples collected from the pit areas, sanitary land fill, lime sludge pond, and fly ash piles at FEMP. Samples were collected in early 1987 for organic and inorganic compounds. Radiological samples were also collected as a part of this task.

4.3.5.1 QA/QC Programs

Collection of samples for the Weston task (March 1987) pre-dates the FEMP RI/FS QAPP which was adopted in March 1988. The sampling procedures utilized for the Weston task appear to be less stringent than those required by the current QA/QC plan.

4.3.5.2 Data Validation Program

The original RI/FS QAPP did not address specific requirements for data validation. These were added via an appendix to the work plan under which the inorganics data was reviewed in November 1990. The validation plan requirements were based on the EPA CLP Statement of Work of February 1988, which post-dates the actual collection of data. The Weston data was re-reviewed in December 1991 to incorporate changes to the validation work plan to address EPA comments. A Site-Wide Data

Validation Plan is currently being implemented which may require further review of the data prior to use.

Under the current Validation Plan, qualifiers are applied to data based on the requirements of the February 1988 EPA CLP Statement of Work and the RI/FS QAPP. Under the plan, qualifiers may be added to data along with an assignment of an ASL based on the deliverables observed. This was necessary to address issues where the intended use of the data was uncertain. Often data is collected at an ASL which is higher than that actually required. The intended ASL for the Weston data appears to have been CLP level IV. A review of the Weston data indicates that this ASL was not attained for all analyses performed.

Field Data

Original field records are unavailable for review and/or verification. To date, none of the Weston field data have been validated. Several of the copies of CoD forms reviewed in the data packages were not readable due to poor copying. Because of the stringent verification requirements for level IV data, it is doubtful that the Weston data as a whole can attain this ASL.

In order to use Weston data, the user must make certain assumptions related to field activities. Since there was no RI/FS QAPP at the time, data may not be comparable to more recently collected data for which detailed collection and verification procedures are available. The user is encouraged to examine field log books, etc. to determine if the sampling procedures used were appropriate for the intended use. The user should look for distinctions such as grab vs. discreet vs. composite sampling techniques.

Inorganics Data

All samples appear to have been validated for inorganics analyses. A commonly encountered problem was that all raw data were hand-written entries in laboratory notebooks. The raw data did not include instrument strip-charts, etc. which are necessary for the verification requirements of ASL IV data. The data also pre-date the February 1988 CLP Statement of Work upon which the RI/FS QAPP and Data Validation plan are based.

Because of these problems, the highest ASL that this data can attain is ASL III which has less stringent reporting requirements than ASL IV. The consideration of data for use at any level is dependent upon an initial assumption that the samples submitted to the laboratory are representative.

Organics Data

A total of 36 samples have been reviewed for organic compounds under CLP format. Analytes include HSL volatiles, semi-volatiles, pesticides/PCBs, and appendix IX compounds. Data were evaluated based on the February 1988 CLP Statement of Work. These samples were reported under seven data packages which were reviewed.

In the data packages reviewed, several of the chromatograms and supporting data could not be read due to poor photocopying, limiting the ability to verify data.

Calibration: The most prevalent problems observed were calibration deficiencies for VOA and BNA analyses. The volatiles fractions had an average of 11 calibrations outside desired performance criteria listed in the SOW. These include chloromethane, bromomethane, 1,2-dichlorobenzene, bromoform, vinyl acetate, 4-methyl-2-pentanone, acrolein, carbon disulfide, acrylonitrile, and trichlorofluoromethane.

The semi-volatiles fraction had an average of 13 calibrations outside desired ranges, and include bis (2-chloroisopropyl)ether, benzo(k)fluoranthene, indeno(1,2,3,c,d)pyrene, N-nitroso-di-n-propylamine, 2,4,5-trichlorophenol, dimethyl phthalate, diethyl phthalate, 4-chlorophenyl-phenylether, and hexachlorobenzene.

Blanks: Blank contaminants were the most prevalent for volatiles analyses. Methylene chloride and acetone were observed with the highest frequency. Two samples for semi-volatiles were observed with blank contamination from phthalate esters.

Surrogate and Matrix Spike Recoveries: Surrogates and matrix spikes were also evaluated. Of the seven data sets reviewed, one surrogate deficiency was observed for volatiles. No surrogate deficiencies were observed for semi-volatiles or pesticide/PCB analyses. Occasional matrix spike deficiencies were noted for semi-volatiles and pesticide/PCBs. These included nitrosopropylamine, pentachlorophenol, p-chloro-m-cresol, acenaphthalene, and 2,4-dinitrotoluene. For one data set, the entire fraction was qualified due to the high number of deficiencies observed. Matrix spike recoveries were outside expected ranges for lindane and aldrin in a few of the packages reviewed.

Radiological Data

At present, it is uncertain whether any of the radiological data collected under the Weston task has been reviewed or validated. The validation program for radiological data consists of a CLP-equivalent review. Radiological data is assigned to ASL V due to the use of non-EPA approved methods. For RI/FS data, reviews are performed from original records maintained at the laboratory. As validated, radiological data should possess the same level of defendability as CLP level IV data with the exception of "validating" the method employed. However, if original sample and QA/QC data and/or copies are not available for review, the validation effort will only be equivalent to an ASL III which is based on a "certificate" that data from the laboratory are within appropriate control limits.

Use of radiological data also depends upon the same assumption that samples collected are representative based on the intended use of the data.

4.3.5.3 Conclusions

Based on the use of professional judgement, it is recommended that Weston data only be used after examining appropriate field records, work plans, etc., and making necessary assumptions related to sample collection.

If based on this review an assumption can be made that the samples collected are representative for the intended use, then the highest ASL attainable for the data would be level III, or level III-equivalent for radiological samples which would still remain at ASL V. If no such assumption can be made, data should be considered as ASL II, or semi-quantitative in nature. None of the Weston Data should be considered usable for regulatory purposes due to the requirements to make assumptions as to representativeness of sampling. Deficiencies observed should be considered as further estimations which must placed on the data.

Part 1 References

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