

**APPENDIX C**  
**DATA VALIDATION SUMMARY REPORTS**

## MEMORANDUM

To: ISTD File  
From: Harry Ellis  
Date: July 1, 2002 (revised February 11, 2003 by Neil Bingert)  
Subject: Data Validation for Pre-Demonstration Samples (VOC, SVOC, and Pesticide Analyses)

This memorandum documents a data validation of the analytical results from soil, waste, and groundwater samples collected during predemonstration sampling for the In Situ Thermal Destruction (ISTD) Technology Evaluation at the "Hex Pit" of the Rocky Mountain Arsenal, Adams County, Colorado. Tetra Tech EM Inc. (Tetra Tech) supported the U.S. Environmental Protection Agency (EPA) with the sampling effort as contracted under the Field Evaluation and Technical Support (FEATS) program.

Tetra Tech collected 30 soil samples (plus two field replicate samples), 15 waste samples (plus two field replicates), and four groundwater samples from July 12 to 30, 2001. The samples were accumulated at the site for 2 or more days, and sent by overnight courier to Accura Analytical Laboratory (AAL) of Norcross, Georgia. AAL analyzed each day's shipment as a separate sample delivery group (SDG), Nos. 28376, 28404, 28443, 28451, 28467, 28502, and 28509. Some samples were analyzed by EPA Test Methods for Evaluating Solid Wastes (SW-846) Method 8270C for hexachlorocyclopentadiene only. Some samples were analyzed by EPA SW-846 Methods 8260B, 8270C, and 8081A for a full array of volatile organic compounds (VOC), semivolatile organic compounds (SVOC), and organochlorine pesticides, respectively. Most samples received only one or two analyses.

The data were evaluated in general accordance with the EPA Contract Laboratory Program National Functional Guidelines (NFG) for organic data review, dated October 1999. The EPA test methods provide guidance on procedures and method acceptance criteria that, in some cases, differ from those in the NFG. When differences exist between the EPA test methods and the NFG, the data validation followed the acceptance criteria given in the methods. In addition, if the data package presented laboratory-specific acceptance criteria, these criteria were used to evaluate the data unless the criteria were considered inadequate. In cases where the criteria in Section 6.0 of the quality assurance project plan (QAPP) are different from the others, the QAPP criteria are used in the validation. The evaluation of the data was based on the following parameters:

- Data package completeness
- Holding times
- Gas chromatography/mass spectroscopy (GC/MS) instrument performance check

**TABLE 1 (Continued)**

**SUMMARY OF PREDEMONSTRATION SAMPLES**

- Initial and continuing calibrations
- Blanks
- Matrix spike/matrix spike duplicate (MS/MSD) analyses
- Laboratory control samples (LCS)
- Internal standards
- Surrogate recoveries
- Compound quantitation

Table 1 lists all samples, SDGs, and analyses performed.

**TABLE 1**

**SUMMARY OF PREDEMONSTRATION SAMPLES**

Sample	SDG No.	Analyses Performed <sup>a</sup>			
		Hex	VOC	SVOC	OCP
PRE-S-E1	28376	X			
PRE-S-E2	28376	X			
PRE-S-E3	28404	X			
PRE-S-E4	28404	X			
PRE-S-E5	28376	X			
PRE-S-E6	28376	X			
PRE-S-E7	28376	X			
PRE-S-E8	28404	X			
PRE-S-E9	28404	X			
PRE-S-E10	28404	X			
PRE-S-E11	28404	X			
PRE-S-E12	28404	X			
PRE-S-1 (VOC)	28443		X		
PRE-S-1 (0-2)	28443			X	X
PRE-S-1 (10-12)	28443			X	X
PRE-S-1 (12-13)	28443	X			X

**TABLE 1 (Continued)**

**SUMMARY OF PREDEMONSTRATION SAMPLES**

Sample	SDG No.	Analyses Performed <sup>a</sup>			
		Hex	VOC	SVOC	OCP
PRE-S-2 (0-2)	28467			X	X
PRE-S-2 (10-12)	28467			X	X
PRE-S-2 (12-13)	28467	X			X
PRE-S-3 (0-2)	28451			X	X
PRE-S-3 (10-12)	28451			X	X
PRE-S-3 (12-13)	28451	X			
PRE-S-6 (VOC)	28467		X		
PRE-S-14 (VOC)	28467		X		
PRE-S-15 (VOC)	28451		X		
PRE-S-16 (VOC)	28443		X		
PRE-S-23 (VOC)	28451		X		
PRE-S-31 (VOC)	28443		X		
PRE-S-33 (VOC)	28443		X		
PRE-S-36 (VOC)	28443		X		
PRE-S-301 (12-13) <sup>b</sup>	28451	X			
PRE-S-302 (12-13) <sup>b</sup>	28451	X			
PRE-W-1 (VOC)	28443		X		
PRE-W-1	28443			X	X
PRE-W-2	28467			X	X
PRE-W-3	28467			X	X
PRE-W-4	28451			X	X
PRE-W-5	28451			X	X
PRE-W-6	28443			X	X
PRE-W-6 (VOC)	28467		X		
PRE-W-14 (VOC)	28467		X		
PRE-W-15 (VOC)	28451		X		
PRE-W-16 (VOC)	28443		X		
PRE-W-23 (VOC)	28451		X		
PRE-W-31 (VOC)	28443		X		
PRE-W-33 (VOC)	28443		X		

**TABLE 1 (Continued)****SUMMARY OF PREDEMONSTRATION SAMPLES**

Sample	SDG No.	Analyses Performed <sup>a</sup>			
		Hex	VOC	SVOC	OCP
PRE-W-36 (VOC)	28443		X		
PRE-W-201 <sup>c</sup>	28467			X	X
PRE-W-202 <sup>c</sup>	28467			X	X
PRE-GW-01111	28502	X			
PRE-GW-01112	28502	X			
PRE-GW-01113	28509	X			
PRE-GW-01114	28509	X			

Notes:

a     HEX   =     Hexachlorocyclopentadiene only  
        VOC   =     Full volatile organic compounds list  
        SVOC  =     Full semivolatile organic compounds list  
        OCP   =     Organochlorine pesticides

b     Field replicate of sample PRE-S-3 (12-13)

c     Field replicate of sample PRE-W-2

**1.0 HEXACHLOROCYCLOPENTADIENE ANALYSES**

This section discusses the SVOC analyses performed for hexachlorocyclopentadiene. Table 2 includes validated results for that compound, including those that were derived during analyses for the full list of SVOCs that are discussed in Section 3.0. No problems were noted with data package completeness, GC/MS instrument performance check, initial and continuing calibrations, blanks, internal standards, or compound quantitation.

Due to a login error, sample PRE-GW-01112 was extracted 8 days after collection, just beyond the 7-day holding time. In addition, the LCS accompanying the initial full-list SVOC analyses was spiked only with hexachlorocyclopentadiene. As a result, these samples were re-extracted with new quality control (QC) samples as much as 2 weeks after the expiration of their holding times. However, hexachlorocyclopentadiene is a relatively stable compound and no qualifications will be applied for these

holding time exceedances.

The MS/MSD analysis with SDG Nos. 28502 and 28509 was performed on sample PRE-GW-01112. Recoveries were 23 and 32 percent, respectively, and recovery from the accompanying LCS sample was 37 percent, versus QC requirements of 50 to 150 percent recovery for both MS and LCS analyses. The MS/MSD analysis also yielded an excessive relative percent difference (RPD) between the two recoveries. The results for hexachlorocyclopentadiene in the samples in that SDG are flagged “UJ” to indicate that the reporting limits are estimated, biased low.

Several sample extracts were diluted so much that surrogate recovery could not be determined. No qualifications are warranted for these data gaps.

Quantitative results were calculated correctly, with soil results corrected to dry weight. Most soil and waste samples were extracted by the medium-level procedure. Extracts were diluted as necessary to bring all positive results within calibration range, so no qualifications are required for quantitation problems.

**TABLE 2**  
**HEXACHLOROCYCLOPENTADIENE RESULTS**

<b>Sample</b>	<b>Concentration</b>	<b>Units</b>
PRE-S-E1	360 U	µg/kg
PRE-S-E2	370 U	µg/kg
PRE-S-E3	370 U	µg/kg
PRE-S-E4	370 U	µg/kg
PRE-S-E5	370 U	µg/kg
PRE-S-E6	360 U	µg/kg
PRE-S-E7	370 U	µg/kg
PRE-S-E8	370 U	µg/kg
PRE-S-E9	370 U	µg/kg
PRE-S-E10	370 U	µg/kg
PRE-S-E11	360 U	µg/kg
PRE-S-E12	370 U	µg/kg
PRE-S-1 (0-2)	11,000 U	µg/kg
PRE-S-1 (10-12)	5,800,000	µg/kg
PRE-S-1 (12-13)	1,100,000	µg/kg

**TABLE 2 (Continued)**

**HEXACHLOROCYCLOPENTADIENE RESULTS**

<b>Sample</b>	<b>Concentration</b>	<b>Units</b>
PRE-S-2 (0-2)	2,800 J	µg/kg
PRE-S-2 (10-12)	1,800,000	µg/kg
PRE-S-2 (12-13)	1,300,000	µg/kg
PRE-S-3 (0-2)	63,000	µg/kg
PRE-S-3 (10-12)	4,400,000	µg/kg
PRE-S-3 (12-13)	920,000	µg/kg
PRE-S-301 (12-13) <sup>a</sup>	1,300,000	µg/kg
PRE-S-302 (12-13) <sup>a</sup>	1,300,000	µg/kg
PRE-W-1	5,500,000	µg/kg
PRE-W-2	8,600,000	µg/kg
PRE-W-3	7,800,000	µg/kg
PRE-W-4	6,000,000	µg/kg
PRE-W-5	11,000,000	µg/kg
PRE-W-6	9,500,000	µg/kg
PRE-W-201 <sup>b</sup>	8,900,000	µg/kg
PRE-W-202 <sup>b</sup>	9,800,000	µg/kg
PRE-GW-01111	10 UJ	µg/L
PRE-GW-01112	10 UJ	µg/L
PRE-GW-01113	10 UJ	µg/L
PRE-GW-01114	10 UJ	µg/L

Notes:

µg/kg = Micrograms per kilogram  
 µg/L = Micrograms per liter

U = Hexachlorocyclopentadiene was not detected. The reported numerical value is the sample quantitation limit.

J = Hexachlorocyclopentadiene was detected, but the result is considered to be estimated for quality control reasons.

UJ = Hexachlorocyclopentadiene was not detected. The sample quantitation limit is considered to be estimated for quality control reasons.

a = Field replicate of sample PRE-S-3 (12-13)

**TABLE 2 (Continued)**

**HEXACHLOROCYCLOPENTADIENE RESULTS**

b = Field replicate of sample PRE-W-2

## 2.0 VOLATILE ORGANIC COMPOUND ANALYSES

This section discusses the results for VOC analyses. Table 3 contains validated results for all samples; only the target compounds reported in at least one sample are listed. No problems were noted with data package completeness, holding times, GC/MS instrument performance checks, LCS analyses, or internal standards. No MS/MSD analyses were performed on samples collected for VOC analyses.

All initial calibration results on both instruments were within QC limits. In the first continuing calibration on the instrument used for the low-level analyses, dichlorodifluoromethane and isobutyl alcohol yielded percent differences (%D) above the QC limit of less than or equal to 25 percent. In the second continuing calibration on that instrument, acetone and methylene chloride yielded %Ds over the 25 percent QC limit. In the only continuing calibration on the instrument used for the medium-level analyses, dichlorodifluoromethane and pentachloroethane yielded excessive %Ds. Results for the named compounds are flagged “J” or “UJ,” as appropriate, in the associated samples to indicate that they are estimates.

The laboratory blanks contained trace levels of 1,2-dichlorobenzene and chloromethane. Similar concentrations of those compounds in some samples were flagged “U” to indicate that they may be laboratory artifacts.

Samples PRE-W-1, PRE-W-16, and PRE-W-33 had recoveries of the third (of three) surrogates, 4-bromofluorobenzene, above the QC limits during low-level analyses. This exceedance was caused by a matrix interference noted in the chromatograms that was confirmed by the absence of surrogate irregularities in the medium level analyses. All positive results for those samples that were derived from the low-level analyses are flagged “J” to indicate that they are estimates.

The VOCs in these samples displayed a wide range of concentrations, much wider than the calibration range. Most samples were analyzed twice, with the second time at a dilution or by the medium-level procedure, in an attempt to bring results within that calibration range. However, the available quantity of sample limited the reanalyses, especially at the lower concentration end, which requires more sample mass. Despite the laboratory’s efforts, some results, such as carbon tetrachloride in sample PRE-S-1, are below the calibration range and others, such as chloroform in that same sample, are above the calibration

range. All such extrapolations are flagged “J” to indicate that they are estimates. The laboratory calculated results correctly, including adjustment to dry weight for soil samples.

**TABLE 3**

**VALIDATED RESULTS OF VOLATILE ORGANIC COMPOUND ANALYSES (µg/kg)**

<b>Sample:</b>	<b>PRE-S-1</b>	<b>PRE-S-6</b>	<b>PRE-S-14</b>	<b>PRE-S-15</b>	<b>PRE-S-16</b>	<b>PRE-S-23</b>	<b>PRE-S-31</b>	<b>PRE-S-33</b>	<b>PRE-S-36</b>
1,1,1,2-Tetrachloroethane	3.0 U	2.8 U	2.9 U	3.7 U	3.4 U	2.8 U	3.3 U	3.3 U	2.8 U
1,1,1-Trichloroethane	3.0 U	2.8 U	2.9 U	3.7 U	3.4 U	2.8 U	3.3 U	3.3 U	2.8 U
1,1,2,2-Tetrachloroethane	3.0 U	2.8 U	2.9 U	3.7 U	3.4 U	2.8 U	3.3 U	3.3 U	2.8 U
1,1,2-Trichloroethane	3.0 U	2.8 U	2.9 U	3.7 U	3.4 U	2.8 U	3.3 U	3.3 U	2.8 U
1,1-Dichloroethane	3.0 U	2.8 U	2.4	4.1	3.4 U	2.8 U	3.3 U	3.3 U	2.8 U
1,1-Dichloroethene	3.0 U	2.8 U	1.3 U	3.7 U	3.4 U	2.8 U	3.3 U	3.3 U	2.8 U
1,2,3-Trichloropropane	3.0 U	2.8 U	2.9 U	3.7 U	3.4 U	2.8 U	3.3 U	3.3 U	2.8 U
1,2-Dichlorobenzene	3.0 U	2.8 U	2.9 U	7.3	3.4 U	2.8 U	3.3 U	3.3 U	2.8 U
1,2-Dichloroethane	3.0 U	2.8 U	2.9 U	3.7 U	3.4 U	2.8 U	3.3 U	3.3 U	2.8 U
1,2-Dichloropropane	3.0 U	2.8 U	0.41 J	3.7 U	3.4 U	2.8 U	3.3 U	3.3 U	2.8 U
1,3-Dichlorobenzene	3.0 U	2.8 U	2.9 U	3.5 J	3.4 U	2.8 U	3.3 U	3.3 U	2.8 U
1,4-Dichlorobenzene	3.0 U	2.8 U	1.3 J	29	3.4 U	0.40 J	3.3 U	3.3 U	2.8 U
2-Butanone	30 U	1.8 J	1.3 J	17 J	5.4 J	2.0 J	2.2 J	1.5 J	1.9 J
2-Hexanone	30 U	28 U	29 U	37 U	34 U	28 U	33 U	33 U	28 U
4-Methyl-2-pentanone	30 U	28 U	29 U	0.99 J	34 U	28 U	33 U	33 U	28 U
Acetone	5.7 J	14 J	16 J	370 J	28 J	18 J	84 J	6.9 J	13 J
Acrolein	60 U	56 U	57 U	75 U	68 U	56 U	66 U	65 U	57 U
Benzene	0.75 J	0.33 J	26	42	0.67 J	2.8 U	3.3 U	0.35 J	2.8 U
Bromomethane	3.0 U	2.8 U	2.9 U	3.7 U	3.4 U	2.8 U	3.3 U	0.45 J	0.31 J
Carbon disulfide	3.0 U	2.8 U	2.9 U	0.78 J	3.4 U	2.8 U	3.3 U	3.3 U	2.8 U
Carbon tetrachloride	0.38 J	3.0	25	2.0 J	56	8.4	27	5.5	12
Chlorobenzene	3.0 U	2.8 U	1.1 J	7.7	3.4 U	2.8 U	3.3 U	3.3 U	2.8 U
Chloroethane	3.0 U	2.8 U	2.9 U	3.7 U	3.4 U	2.8 U	3.3 U	3.3 U	2.8 U
Chloroform	240 J	64	3,700	8.3	100	290	720 J	39	47

**TABLE 3 (Continued)**

**VALIDATED RESULTS OF VOLATILE ORGANIC COMPOUND ANALYSES (µg/kg)**

<b>Sample:</b>	<b>PRE-S-1</b>	<b>PRE-S-6</b>	<b>PRE-S-14</b>	<b>PRE-S-15</b>	<b>PRE-S-16</b>	<b>PRE-S-23</b>	<b>PRE-S-31</b>	<b>PRE-S-33</b>	<b>PRE-S-36</b>
Chloromethane	3.0 U	2.8 U	22	37	3.4 U	2.8 U	3.3 U	3.3 U	2.8 U
Dichlorodifluoromethane	1.6 J	1.0 J	1.1 J	2.1 J	7.1 J	1.5 J	1.8 J	2.1 J	1.6 J
Ethylbenzene	3.0 U	2.8 U	0.73 J	14	3.4 U	2.8 U	3.3 U	0.33 J	2.8 U
Isobutyl alcohol	0.62 J	28 UJ	29 UJ	37 UJ	34 UJ	28 UJ	33 UJ	33 UJ	0.34 J
Methylene chloride	6.0 UJ	5.6 UJ	6.2 J	50 J	1.5 J	5.6 UJ	0.51 J	6.5 UJ	5.7 UJ
Pentachloroethane	3.0 U	2.8 U	2.9 U	3.7 U	3.4 U	2.8 U	3.3 U	3.3 U	2.8 U
Styrene	3.0 U	2.8 U	2.9 U	3.7 U	3.4 U	2.8 U	3.3 U	3.3 U	2.8 U
Tetrachloroethene	13	21	330 J	500 J	67	18	60	20	38
Toluene	1.8 J	1.7 J	1.0 J	4.1	8.5	1.7 J	2.4 J	1.4 J	0.77 J
trans-1,2-Dichloroethene	3.0 U	2.8 U	0.70 J	3.7 U	3.4 U	2.8 U	3.3 U	3.3 U	2.8 U
Trichloroethene	1.3 J	1.9 J	58	10	1.8 J	1.0 J	2.9 J	0.48 J	1.0 J
Trichlorofluoromethane	3.0 U	2.8 U	2.9 U	3.7 U	0.50 J	2.8 U	3.3 U	0.34 J	2.8 U
Xylenes	1.3 J	1.2 J	2.5 J	48	0.69 J	0.32 J	0.61 J	1.6 J	0.64 J

<b>Sample:</b>	<b>PRE-W-1</b>	<b>PRE-W-6</b>	<b>PRE-W-14</b>	<b>PRE-W-15</b>	<b>PRE-W-16</b>	<b>PRE-W-23</b>	<b>PRE-W-31</b>	<b>PRE-W-33</b>	<b>PRE-W-36</b>
1,1,1,2-Tetrachloroethane	2.3 J	4.1 U	7.1 U	6.0 U	1.9 J	2.8 U	4,000 U	3.1 U	2.9 U
1,1,1-Trichloroethane	3.8 U	4.1 U	7.1 U	2.3 J	8.4 J	1.2 J	4,000 U	1.8 J	2.6 J
1,1,2,2-Tetrachloroethane	3.6 J	4.1 U	7.1 U	6.0 U	3.4 U	1.5 J	4,000 U	2.3 J	3.2
1,1,2-Trichloroethane	1.6 J	4.1 U	7.1 U	6.0 U	3.2 J	1.7 J	4,000 U	3.1 U	2.9 U
1,1-Dichloroethane	3.8 U	0.76 J	4.3 J	5.2 J	3.4 U	1.9 J	4,000 U	3.1 U	0.94 J
1,1-Dichloroethene	3.8 U	4.1 U	7.1 U	1.2 J	3.4 U	0.52 J	4,000 U	3.1 U	2.9 U
1,2,3-Trichloropropane	3.8 U	4.1 U	7.1 U	6.0 U	3.4 U	2.8 U	4,000 U	4.4 J	2.9 U
1,2-Dichlorobenzene	9.9 J	4.1 U	7.1 U	6.0 U	550	2.9 U	4,000 U	3.1 U	36 J

**TABLE 3 (Continued)**

**VALIDATED RESULTS OF VOLATILE ORGANIC COMPOUND ANALYSES (µg/kg)**

<b>Sample:</b>	<b>PRE-W-1</b>	<b>PRE-W-6</b>	<b>PRE-W-14</b>	<b>PRE-W-15</b>	<b>PRE-W-16</b>	<b>PRE-W-23</b>	<b>PRE-W-31</b>	<b>PRE-W-33</b>	<b>PRE-W-36</b>
1,2-Dichloroethane	3.8 U	0.68 J	7.1 U	6.0 U	3.4 U	2.8 U	4,000 U	3.1 U	2.9 U
1,2-Dichloropropane	1.0 J	4.1 U	7.1 U	1.2 J	3.4 U	2.8 U	4,000 U	0.81 J	2.9 U
1,3-Dichlorobenzene	13 J	4.1 U	7.1 U	0.65 J	240 J	2.1 J	4,000 U	2.0 J	46 J
1,4-Dichlorobenzene	50 J	2.0 J	12	7.0	1,000	15	840 J	12 J	110 J
2-Butanone	9.6 J	22 J	39 J	15 J	7.7 J	5.5 J	40,000 U	9.7 J	4.1 J
2-Hexanone	38 U	0.48 J	1.5 J	60 U	34 U	28 U	40,000 U	31 U	29 U
4-Methyl-2-pentanone	38 U	0.72 J	2.6 J	60 U	34 U	28 U	40,000 U	0.87 J	1.6 J
Acetone	81 J	280 J	850 J	200 J	1,100 J	54 J	2,500 J	140 J	52 J
Acrolein	76 U	82 U	140 U	120 U	1.2 J	56 U	81,000 U	63 U	59 U
Benzene	5.5 J	30	23	8.0	0.72 J	6.3	4,000 U	4.4 J	3.6 J
Bromomethane	0.61 J	4.1 U	7.1 U	6.0 U	3.4 U	2.8 U	4,000 U	3.1 U	2.9 U
Carbon disulfide	3.8 U	2.1 J	6.2 J	6.0 U	3.4 U	2.8 U	4,000 U	3.1 U	2.9 U
Carbon tetrachloride	8,600	9.9	35	490 J	3,800	580 J	13,000	4,600	5,600
Chlorobenzene	3.8 U	4.1 U	0.84 J	36	3.4 U	0.82 J	4,000 U	4.3 J	16 J
Chloroethane	3.8 U	4.1 U	7.1 U	6.0 U	9.5 J	9.1	4,000 U	3.1 U	2.9 U
Chloroform	22,000	170	150	2,300 J	2,400	1,100 J	4,600	580 J	470 J
Chloromethane	4.0 U	47	150	19	18 J	9.0	15,000	24 J	19 J
Dichlorodifluoromethane	2.4 J	1.8 J	3.5 J	1.2 J	1.4 J	1.3 J	4,000 UJ	2.0 J	1.8 J
Ethylbenzene	1.3 J	1.9 J	2.2 J	6.0 U	11 J	0.91 J	4,000 U	3.8 J	6.5 J
Isobutyl alcohol	38 UJ	41 UJ	71 UJ	60 UJ	34 UJ	28 UJ	40,000 U	31 UJ	29 UJ
Methylene chloride	7.6 UJ	17 J	52 J	12 UJ	24 J	4.7 J	1,600 J	50 J	19 J
Pentachloroethane	61 J	4.1 U	7.1 U	6.0 U	3.4 U	0.58 J	4,000 UJ	30 J	57 J
Styrene	3.8 U	4.1 U	2.4 J	6.0 U	3.4 U	2.8 U	4,000 U	3.1 U	2.9 U
Tetrachloroethene	4,800	84	200	1,200 J	6,700	480 J	3,700 J	350 J	4,300

**TABLE 3 (Continued)**

**VALIDATED RESULTS OF VOLATILE ORGANIC COMPOUND ANALYSES (µg/kg)**

<b>Sample:</b>	<b>PRE-W-1</b>	<b>PRE-W-6</b>	<b>PRE-W-14</b>	<b>PRE-W-15</b>	<b>PRE-W-16</b>	<b>PRE-W-23</b>	<b>PRE-W-31</b>	<b>PRE-W-33</b>	<b>PRE-W-36</b>
Toluene	5.8 J	1.9 J	11	2.8 J	280 J	1.7 J	4,000 U	9.2 J	3.4 J
trans-1,2-Dichloroethene	3.8 U	4.1 U	7.1 U	6.0 U	3.4 U	0.62 J	4,000 U	3.1 U	2.9 U
Trichloroethene	67 J	9.2	31	73	53 J	61	540 J	24 J	29 J
Trichlorofluoromethane	3.8 U	4.1 U	7.1 U	6.0 U	3.4 U	2.8 U	4,000 U	3.1 U	2.9 U
Xylenes	4.0 J	6.6	11	1.2 J	210 J	2.8	720 J	8.7 J	20 J

Notes:

µg/kg = Micrograms per kilogram

U = The compound was not detected. The reported numerical value is the sample quantitation limit.

J = The compound was detected, but the result is considered to be estimated for quality control reasons.

UJ = The compound was not detected. The sample quantitation limit is considered to be estimated for quality control reasons.

### 3.0 SEMIVOLATILE ORGANIC COMPOUND ANALYSES

This section discusses the results for the full-list SVOC analyses. Table 4 contains validated results for all samples; only compounds reported in at least one sample are listed. No problems were noted with data package completeness, GC/MS instrument performance checks, initial and continuing calibrations, blanks, MS/MSD analyses, LCS analyses, or internal standards.

The LCS accompanying the initial analyses was spiked with hexachlorocyclopentadiene only, and the analyses showed that the samples were generally complex mixtures with high concentration of SVOCs. Several extracts could not be concentrated to 1.0 milliliter, and the analyst described these extracts as “thick, dark, and nasty.” The laboratory discarded these initial results and reextracted all samples 3 to 4 weeks after collection, beyond the holding time limit of 14 days. However, all of the detected compounds are relatively stable and very persistent in the environment. Since the samples were kept well cooled (below their original, in situ temperature) from collection until extraction, no qualifications are warranted for these delays.

A few extracts exhibited low recoveries for one acidic surrogate, 2,4,6-tribromophenol. No qualifications are warranted for such minor irregularities with only one surrogate. Many extracts were so diluted (up to 500-fold) that surrogate recoveries could not be determined. No qualifications are warranted for these data gaps.

Calculations were performed correctly, with soil results adjusted to dry weight. Most sample extracts were diluted (and some diluted more than once) to bring the more concentrated contaminants into calibration range. However, some results were below the calibration range in the least diluted analytical run. These extrapolations are flagged “J” to indicate that they are estimates.

**TABLE 4**

**VALIDATED RESULTS FOR SEMIVOLATILE ORGANIC COMPOUNDS (µg/kg)**

Sample:	PRE-S-1 (0-2)	PRE-S-1 (10-12)	PRE-S-2 (0-2)	PRE-S-2 (10-12)	PRE-S-3 (0-2)	PRE-S-3 (10-12)	PRE-W-1
1,2,4-Trichlorobenzene	11,000 U	530,000 U	13,000 U	11,000 U	11,000 U	13,000 U	490,000 U
2-Chloronaphthalene	11,000 U	530,000 U	13,000 U	11,000 U	11,000 U	13,000 U	490,000 U
4-Chlorophenyl phenyl ether	11,000 U	530,000 U	13,000 U	11,000 U	11,000 U	13,000 U	490,000 U
Fluoranthene	11,000 U	530,000 U	4,900 J	11,000 U	11,000 U	13,000 U	490,000 U
Hexachlorobenzene	29,000	410,000 J	45,000	130,000	44,000	520,000	1,300,000
Hexachlorobutadiene	11,000 U	530,000 U	4,700 J	11,000 U	11,000 U	89,000	380,000 J
Hexachlorocyclopentadiene	11,000 U	5,800,000	2,800 J	1,800,000	63,000	4,400,000	5,500,000
Hexachloroethane	11,000 U	530,000 U	13,000 U	10,000 J	11,000 U	40,000	490,000 U
Naphthalene	11,000 U	530,000 U	13,000 U	11,000 U	11,000 U	13,000 U	490,000 U
Phenanthrene	11,000 U	530,000 U	3,300 J	11,000 U	11,000 U	13,000 U	490,000 U
Pyrene	11,000 U	530,000 U	3,800 J	11,000 U	11,000 U	13,000 U	490,000 U

Sample:	PRE-W-2	PRE-W-3	PRE-W-4	PRE-W-5	PRE-W-6	PRE-W-201 <sup>a</sup>	PRE-W-202 <sup>a</sup>
1,2,4-Trichlorobenzene	570,000 U	630,000 U	5,200 J	600,000 U	580,000 U	560,000 U	600,000 U
2-Chloronaphthalene	570,000 U	630,000 U	10,000 J	600,000 U	580,000 U	560,000 U	600,000 U
4-Chlorophenyl phenyl ether	570,000 U	630,000 U	11,000 J	600,000 U	580,000 U	560,000 U	600,000 U
Fluoranthene	570,000 U	630,000 U	14,000 U	600,000 U	580,000 U	560,000 U	600,000 U
Hexachlorobenzene	4,100,000	3,600,000	2,100,000	3,000,000	2,600,000	5,300,000	5,700,000
Hexachlorobutadiene	240,000 J	200,000 J	180,000	290,000 J	250,000 J	270,000 J	310,000 J
Hexachlorocyclopentadiene	8,600,000	7,800,000	6,000,000	11,000,000	9,500,000	8,900,000	9,800,000
Hexachloroethane	570,000 U	630,000 U	92,000	130,000 J	120,000 J	560,000 U	600,000 U
Naphthalene	570,000 U	630,000 U	13,000 J	600,000 U	580,000 U	560,000 U	600,000 U
Phenanthrene	570,000 U	630,000 U	14,000 U	600,000 U	580,000 U	560,000 U	600,000 U
Pyrene	500,000 U	630,000 U	14,000 U	600,000 U	580,000 U	560,000 U	600,000 U

Notes:

- µg/kg = Micrograms per kilogram
- U = The compound was not detected. The reported numerical value is the sample quantitation limit.
- J = The compound was detected, but the result is considered to be estimated for quality control reasons.
- a = Field replicate of sample PRE-W-2

#### 4.0 ORGANOCHLORINE PESTICIDE ANALYSES

This section discusses the results for organochlorine pesticide analyses. Table 5 contains validated results for all samples; only compounds reported in at least one sample are listed. No problems were noted with data package completeness, holding times, or initial calibrations. (GC/MS instrument performance check and internal standards are not relevant to organochlorine pesticide analyses.)

During continuing calibrations, an occasional result in one column was outside QC limits. Since the other column results were acceptable, no qualifications are warranted.

The laboratory blank contained low-level concentrations of aldrin, dieldrin, endrin, and endrin ketone. The samples contained such high concentrations of pesticides (including these four) however, that no qualifications are warranted.

MS/MSD analyses were performed on sample PRE-W-1, but results were not usable because the parent sample contained much higher concentrations of pesticides than the spikes. No qualifications are warranted for this data gap.

The LCS analysis reported a recovery of 160 percent for dieldrin, above QC limits of 57 to 123 percent. All dieldrin results are flagged “J” to indicate that they are estimates biased high.

In most analyses, surrogate recoveries could not be determined due to the high dilutions. No qualifications are warranted for these data gaps.

As noted above, sample extracts were diluted for analysis due to the high concentrations of pesticides. The results in Table 5 are derived from dilutions ranging from 200-fold to 200,000-fold. Two or three dilutions were used for each sample, so no results exceeded the calibration range. However, some results were below the calibration range in the least diluted analysis. These extrapolations are flagged “J” to indicate that they are estimates.

**TABLE 5**

**VALIDATED RESULTS FOR ORGANOCHLORINE PESTICIDE ANALYSES (µg/kg)**

<b>Sample:</b>	<b>PRE-S-1 (0-2)</b>	<b>PRE-S-1 (10-12)</b>	<b>PRE-S-1 (12-13)</b>	<b>PRE-S-2 (0-2)</b>	<b>PRE-S-2 (10-12)</b>	<b>PRE-S-2 (12-13)</b>	<b>PRE-S-3 (0-2)</b>	<b>PRE-S-3-(10-12)</b>
4,4'-DDD	3,600 U	3,700 U	940 U	21,000 U	8,200	4,900	360 U	1,100 U
4,4'-DDD	3,600 U	3,700 U	940 U	21,000 U	940 U	940 U	360 U	1,100 U
Aldrin	7,400	26,000	7,000	140,000	15,000	9,900	1,300	3,200
alpha-BHC	3,600 U	4,700	940 U	21,000 U	940 U	940 U	360 U	1,100 U
beta-BHC	3,600 U	3,700 U	940 U	21,000 U	940 U	940 U	360 U	1,100 U
Dieldrin	85,000 J	150,000 J	59,000 J	4,500,000 J	63,000 J	34,000 J	13,000 J	21,000 J
Endrin	3,700	3,700 U	940 U	53,000	940 U	940 U	1,200	1,100 U
Endrin ketone	3,900	3,700 U	940 U	6,500 J	8,300	2,700	2,500	1,100 U
Heptachlor	3,600 U	3,700 U	940 U	21,000 U	940 U	940 U	360 U	1,100 U

<b>Sample:</b>	<b>PRE-W-1</b>	<b>PRE-W-2</b>	<b>PRE-W-3</b>	<b>PRE-W-4</b>	<b>PRE-W-5</b>	<b>PRE-W-6</b>	<b>PRE-W-201<sup>a</sup></b>	<b>PRE-W-202<sup>a</sup></b>
4,4'-DDD	3,900 U	52,000	51,000	1,300 U	4,000 U	3,900 U	23,000	29,000
4,4'-DDD	3,900 U	4,000 U	11,000 U	1,300 U	14,000	3,900 U	4,000 U	10,000
Aldrin	110,000 J	700,000	110,000	40,000 J	1,400,000	3,800 J	490,000	570,000
alpha-BHC	3,900 U	4,000 U	11,000 U	1,300 U	4,000 U	3,900 U	4,000 U	4,000 U
beta-BHC	3,900 U	11,000	11,000 U	1,300 U	4,000 U	3,900 U	4,000 U	4,000 U
Dieldrin	1,300,000 J	1,700,000 J	360,000 J	280,000 J	1,500,000 J	23,000 J	1,200,000 J	1,200,000 J
Endrin	25,000	62,000	11,000 U	9,400	63,000	3,900 U	47,000	53,000
Endrin ketone	14,000	14,000	11,000 U	4,500	47,000	3,900 U	8,900	11,000
Heptachlor	3,900 U	15,000	4,400 J	1,300 U	20,000	3,900 U	11,000	11,000

Notes:

- µg/kg = Micrograms per kilogram
- U = The compound was not detected. The reported numerical value is the sample quantitation limit.
- J = The compound was detected, but the result is considered to be estimated for quality control reasons.
- a = Field replicate of sample PRE-W-2

## 5.0 OVERALL EVALUATION

Given the nature of the samples, analytical results and laboratory analyses appear to be acceptable, as qualified. Some laboratory errors (such as an apparent miscommunication that led to misspiking the first SVOC LCS) made little difference in the results. The samples contain many organic compounds, and many of the samples exhibit high concentrations of these contaminants. This complexity tends to produce significant matrix interferences, seen as irregularities in MS/MSD analyses, surrogate recoveries, and internal standard results. Some such problems were seen, but they were not severe enough to render the results unusable. Highly contaminated samples like these often have irregular distributions of the contaminants because the samples are a physical mixture of organic particles (containing most of the contaminants) within the bulk matrix of soil or water.

February 10, 2003

Memo to: ISTD File  
From: Harry Ellis  
Re: Data Validation for Pre-Demonstration Samples (Dioxin Analyses)

This memorandum documents a data validation of the analytical results from soil samples collected during the pre-demonstration sampling for the In Situ Thermal Destruction (ISTD) Technology carried out at the "Hex Pit" of the Rocky Mountain Arsenal, Adams County, Colorado, under the auspices of the U.S. Environmental Protection Agency (EPA) Field Evaluation and Technical Support (FEATS) program by Tetra Tech EM Inc. (Tetra Tech) and its subcontractor, Kemron Environmental Services (Kemron). A total of 12 composite soil samples and two replicate soil samples were collected by Tetra Tech on July 18 through 25, 2001, and sent in three shipments by overnight courier to Triangle Laboratories, Inc. (Triangle), of Durham, North Carolina. Triangle analyzed the samples for polychlorinated dibenzo(p)dioxins and polychlorinated dibenzofurans (dioxins) by EPA Test Methods for Evaluating Solid Wastes (SW-846) Method 8290. Each shipment was analyzed as a separate sample delivery group (SDG), Nos. 54747, 54763, and 54787. Additional samples were sent to another laboratory for other analyses; those analyses have been discussed in a separate memorandum.

The data were evaluated in general accordance with the EPA Contract Laboratory Program National Functional Guidelines (NFG) for dioxin review, dated August 2002. When differences exist between the SW-846 method and the NFG, the data validation followed the acceptance criteria given in the method. In addition, when Triangle gave laboratory-specific acceptance criteria, then these criteria were used to evaluate the data. The evaluation of the data was based on the following quality control (QC) parameters.

- Data package completeness
- Holding times
- Instrument performance check
- Initial and continuing calibrations
- Blanks
- Matrix spike/matrix spike duplicate (MS/MSD) analyses
- Laboratory control samples (LCS)
- Internal standards
- Surrogate recoveries
- Compound quantitation

The following sections discuss, in turn, the three SDGs. A final section provides an overall evaluation of the analyses and is followed by tables summarizing the validated analytical results.

## **1.0 SDG No. 54747**

SDG No. 54747 included four soil samples collected July 18 and 19. There were no problems with data package completeness, holding times, instrument performance checks, LCS results, and surrogate recoveries. Validated analytical results are summarized in Table 1.

The closing continuing calibration performed after the analysis of the undiluted extracts had some unacceptable results due to carryover from the samples. Since the affected analytes were quantitated from diluted reanalyses, no qualifications are required.

Some of the laboratory blanks contained low-level concentrations of analytes. The samples contained much higher concentrations of the analytes (or of interfering nontargets), so no qualifications are required.

This SDG included no MS/MSD analyses. Duplicate LCS analyses provided adequate checks of accuracy and precision, so no qualifications are warranted for this data gap.

In a few cases, such as hexachlorodibenzofurans (HxCDF) and heptachlorodibenzofurans (HpCDF) in the undiluted analysis of sample PRE-S-1 (0-2), co-eluting nontarget compounds gave the internal standards an ion ratio outside QC limits. No such results were used for quantitation, so no qualifications are required for this problem. In addition, some internal standards had recoveries outside their QC limits, usually above the limits due to the presence of nontarget compounds. In most cases, the sample was reanalyzed at a different dilution with acceptable recoveries so no qualifications are required. The exception was sample PRE-S-1 (10-12) where three internal standards were outside their QC limits in the undiluted analysis. For instance, the recovery for <sup>13</sup>C<sub>12</sub>-2,3,7,8-tetrachlorodibenzo(p)dioxin (TCDD) was 197 percent, versus QC limits of 25 to 164 percent. Therefore, the results for 2,3,7,8-TCDD and other similarly affected analytes are flagged “J” to indicate that they are estimated, biased low.

These samples produced numerous problems with quantitation, which Triangle worked diligently to minimize. First, all samples were analyzed undiluted. Many analytes exceeded their calibration range and most of those saturated the detector. Therefore, Triangle reextracted the samples (using a smaller

portion of soil) and diluted those extracts to reach 1,000-fold dilutions. One sample was analyzed a third time at a 12,000-fold dilution and one at a 25-fold dilution. Due to these repeated attempts, almost all of the results in Table 1 are within the calibration range of one dilution, so they are not qualified. A few results are above the calibration range from a less diluted sample but below the range for a more diluted one (calibration standards cover a 200-fold range), so these extrapolations are flagged “J” to indicate that they are estimated.

In this analysis, the detection limits are generally calculated from the definition of a peak, namely that it has a signal-to-noise ratio of 2.5 or more. This applies to the nondetect result for 2,3,4,7,8-pentachlorodibenzofuran (PeCDF) in sample PRE-S-1 (0-2). But in a number of cases, such as 2,3,7,8-tetrachlorodibenzofuran (TCDF) in that same sample, a peak was present in the window for the analyte but it was outside the acceptable range of isotope ratios. Therefore, the peak was partially or completely nontarget compounds. When this occurs, the detection limit is calculated from the interfering peak and is called in the laboratory report the “estimated maximum possible concentration” or EMPC. Table 1 does not distinguish between these two types of detection limits.

Finally, in a few cases, such as total TCDF in sample PRE-S-1 (0-2), polychlorinated diphenyl ethers (PCDPE) are contributing to the apparent mass of analytes. The laboratory sorted out the PCDPE from the dioxins as much as possible, but the results are flagged “J” to indicate that they are estimated.

## **2.0 SDG No. 54763**

SDG No. 54763 includes four soil samples collected on 20 and 23 July. There were no problems with data package completeness, holding times, instrument performance check, LCS results, and surrogate recoveries. Validated analytical results are summarized in Table 2.

Almost all calibration results were acceptable. The initial analyses of these samples were performed in the same analytical run as the samples in SDG No. 54747. The closing continuing calibration had results outside QC limits due to carryover from some of the samples. No qualifications are applied for this irregularity.

Some of the laboratory blanks contained low-level concentrations of a few analytes. The samples contained much higher concentrations, so no qualifications are warranted.

No MS/MSD analyses were included in this SDG. Duplicate LCS analyses provided adequate evidence of acceptable accuracy and precision, so no qualifications are warranted for this data gap.

A few of the internal standard recoveries exceeded QC limits. For instance, in the original analysis of sample PRE-S-3 (10-12), the recovery of  $^{13}\text{C}_{12}$ -1,2,3,6,7,8-HxCDF was 170 percent versus QC limits of 26 to 123 percent. The HxCDF analytes were quantitated from a more diluted analysis (with acceptable internal standard recoveries), so no qualifications were warranted. However,  $^{13}\text{C}_{12}$ -1,2,3,6,7,8-hexachlorodibenzo(p)dioxin (HxCDD) had a 198 percent recovery, versus QC limits of 28 to 130 percent. Since all three HxCDD isomers were quantitated against this internal standard, they are flagged “J” to indicate that they are estimated, biased low. Similar considerations apply to other internal standards in this and other samples.

These samples contained many target analytes and even more nontarget compounds, which interfered with the analyses. All samples were reextracted and reanalyzed at a dilution. Sample PRE-S-3 (10-12) was also analyzed at a third, intermediate dilution. Despite this, a few results were above the calibration range at one dilution and below it in the next higher dilution. These extrapolations are flagged “J” to indicate that they are estimated. In some cases, peaks appeared in the windows for analytes, but the isotope ratios were outside the acceptable range. Therefore, the peaks were partially or completely nontarget compounds. These results are flagged “U” to indicate that the analyte was not detected and the size of the nontarget peak was used to calculate the sample quantitation limit (called an EMPC by the laboratory).

Finally, it is well known that 2,3,7,8-TCDF cannot be separated from some (relatively nontoxic) isomers, especially 2,3,4,7-TCDF and 1,2,3,9-TCDF, on the primary chromatography column. Therefore, the extract is reanalyzed on a second column to confirm the identity. With sample PRE-S-3 (10-12), the second column did not confirm the presence of 2,3,7,8-TCDF. Therefore, the result is flagged “U” to indicate that it is a false positive.

### **3.0 SDG No. 54787**

SDG No. 54787 includes four soil samples and two replicate samples (a field triplicate) collected on 24 and 25 July. There were no problems with data package completeness, holding times, instrument performance checks, initial and continuing calibrations, LCS results, internal standards, and surrogate recoveries. Validated analytical results are summarized in Table 3.

Some of the laboratory blanks contained low-level concentrations of some analytes. However, all samples contained much higher concentrations of analytes, interferents, or both, so no qualifications are warranted.

MS/MSD analyses were performed on two samples, PRE-S-2 (10-12) and PRE-W-3. In both cases, accuracy could not be determined from the percent recovery data since the field sample concentrations were much more (generally orders of magnitude more) than the amounts spiked. Since all LCS results were acceptable, no qualifications are warranted for this data gap. The precision results (determined from the relative percent difference data) were quite good for the MS/MSD analyses on sample PRE-S-2 (10-12). In contrast, precision was poor for the MS/MSD analyses on sample PRE-W-3, with all MSD results about twice the MS results. This same sort of irregularity was seen with the field triplicate samples, since the primary sample (PRE-W-2) contained considerably more than the first replicate sample (PRE-W-201), which contained somewhat more than the second replicate sample (PRE-W-202). These results show that in many places there may be considerable local variations in the dioxin content of the soil, giving different quantitative results for different 12 to 13 gram portions from the field sample.

As with earlier SDGs, Triangle worked to get usable results. The initial analyses were performed at 1,000- or 2,000-fold dilutions. Some samples were reanalyzed at a greater dilution to bring higher concentrations within calibration range and some were reanalyzed at a 50-fold dilution to bring lower concentration results within calibration range. Despite all this work, some positive results [such as 1,2,3,7,8-pentachlorodibenzo-p-dioxin in sample PRE-S-2 (0-2)] were still below the calibration range. These extrapolations are flagged “J” to indicate that they are estimated. As defined in the method, there are two types of sample quantitation limits shown in the results. When there is no peak in the analyte window that has a signal-to-noise level of 2.5 or more, the listed value is the “detection level” of 2.5 times the noise. This applies to results such as 2,3,7,8-TCDD in sample PRE-S-2 (0-2). When there is a peak in the window but it fails the mass ratio test (indicating that it is, at least in part, a nontarget compound) the peak size is used to calculate an EMPC, as for 1,2,3,4,7,8-HxCDD in the same sample.

#### **4.0 OVERALL EVALUATION**

On the whole, the laboratory did as well as could be expected from the characteristics of the samples (highly contaminated, heterogenous) and the need to produce some usable numbers without delaying to carry out a research project on each sample. The results are usable as qualified for any purpose.

As summarized in Tables 1 through 3, about half the samples contained measurable concentrations of all 17 individual 2,3,7,8-substituted analytes. The others contained most of the target analytes. To provide a measure of the total adverse effects of these analytes, one uses the procedures in the method to calculate the “toxicity equivalent” for each sample. This is essentially the concentration of 2,3,7,8-TCDD that would have the same adverse effects as the entire mixture of contaminants because 2,3,7,8-TCDD has a toxicity equivalent factor of 1.00. These toxicity equivalents are generally used in risk assessments and other risk-based decision making. Table 4 summarizes the results of the toxicity equivalent calculation for these samples. For samples with one or more nondetect results, three calculations are presented. The first (labeled “maximum”) calculation assumes that nondetected analytes are actually present at their quantitation limits, whether that is an actual detection limit or an estimated maximum possible concentration, as discussed for this SDG. The second calculation (labeled “minimum”) assumes the nondetected analytes are completely absent. The third calculation (labeled “median”) assumes that the true concentrations of nondetected analytes are half their quantitation limits. This “median” estimation is routinely used in risk assessment and is probably the most realistic. These samples have such high concentrations that the differences in the toxicity equivalent calculations produce negligible differences in biological effect estimates.

The primary technical problem with these analyses was interference from high concentrations of both target analytes and other compounds. The nontarget compounds are apparently closely related to the target ones since they respond readily to the detectors. The source of these samples is the disposal site for wastes from the manufacture of hexachlorocyclopentadiene. The manufacturing processes include heating various compounds in the presence of some oxygen sources, which may result in the generation of target compounds, especially highly chlorinated dibenzofurans. As discussed above for the MS/MSD analyses, there is good evidence of local heterogeneity in the dioxin concentrations. However, the relative concentrations of the various analytes within different portions of the same sample are essentially consistent. The simplest explanation for this is that the waste composition, in terms of dioxin compounds and their proportions, was relatively consistent over the years of production. One would expect this from a single manufacturing process and highly stable products. Therefore, the inconsistencies are practically limited to the total concentrations (expressed as toxicity equivalents) over space.

There is one significant consequence of this spatial heterogeneity. No single sample can be considered fully “representative” of its source area. Many samples, more than those discussed here, are needed to define an “average” concentration of dioxins in the pit. Therefore, it will be difficult to compare the post-demonstration results to these pre-demonstration results. Even if post-demonstration samples are taken

within a few centimeters of the locations used here, differences between the results may be due to heterogeneity. To minimize the probability of error, it would be reasonable to consider a change of less than 10-fold in the toxicity equivalent to be a “no effect” response.

**TABLE 1**

**SUMMARY OF VALIDATED DIOXIN RESULTS FROM SDG NO. 54747**  
(nanograms per kilogram)

<b>Sample Location:</b>	<b>PRE-S-1 (0-2)</b>	<b>PRE-S-1 (10-12)</b>	<b>PRE-W-1</b>	<b>PRE-W-6</b>
2,3,7,8-Tetrachlorodibenzo(p)dioxin	11.2	600 J	940	500 U
1,2,3,7,8-Pentachlorodibenzo(p)dioxin	83	4,900 J	7,600	4,600
1,2,3,4,7,8-Hexachlorodibenzo(p)dioxin	180	11,100	21,000	10,600
1,2,3,6,7,8-Hexachlorodibenzo(p)dioxin	200	10,700 J	22,000	11,600
1,2,3,7,8,9-Hexachlorodibenzo(p)dioxin	220	11,800 J	19,000	12,300
1,2,3,4,6,7,8-Heptachlorodibenzo(p)dioxin	1,150	68,000 J	171,000	70,000
Octachlorodibenzo(p)dioxin	2,400 J	75,000 J	330,000	105,000
2,3,7,8-Tetrachlorodibenzofuran	880 U	76,200	91,000 U	128,000
1,2,3,7,8-Pentachlorodibenzofuran	7,500 J	420,000	670,000	660,000
2,3,4,7,8-Pentachlorodibenzofuran	133 U	94,000	156,000	94,000
1,2,3,4,7,8-Hexachlorodibenzofuran	14,600 J	950,000	1,840,000	1,240,000
1,2,3,6,7,8-Hexachlorodibenzofuran	5,000	600,000	1,130,000	740,000
2,3,4,6,7,8-Hexachlorodibenzofuran	1,750	170,000	300,000	250,000
1,2,3,7,8,9-Hexachlorodibenzofuran	2,700	145,000	250,000	210,000
1,2,3,4,6,7,8-Heptachlorodibenzofuran	26,000 J	2,000,000	4,500,000	2,200,000
1,2,3,4,7,8,9-Heptachlorodibenzofuran	14,800 U	1,140,000	2,500,000	1,300,000
Octachlorodibenzofuran	280,000	12,500,000	30,000,000	52,000,000
Total tetrachlorodibenzo(p)dioxins	500	27,000	55,000	34,000
Total pentachlorodibenzo(p)dioxins	1,110	39,000	71,000	50,000
Total hexachlorodibenzo(p)dioxins	2,300	146,000	230,000	137,000
Total heptachlorodibenzo(p)dioxins	2,000	142,000	320,000	139,000
Total tetrachlorodibenzofurans	7,000 J	750,000	610,000	1,400,000
Total pentachlorodibenzofurans	17,000	1,360,000	1,900,000	2,400,000
Total hexachlorodibenzofurans	29,000	2,900,000	5,200,000	3,900,000
Total heptachlorodibenzofurans	37,000	3,900,000	8,600,000	4,500,000

Notes:

- J = The analyte was detected. The reported numerical value is considered to be estimated for quality control reasons.  
 U = The analyte was not detected. The reported numerical value is the sample quantitation limit.

**TABLE 2**

**SUMMARY OF VALIDATED DIOXIN RESULTS FROM SDG NO. 54763**  
(nanograms per kilogram)

<b>Sample Location:</b>	<b>PRE-S-3 (0-2)</b>	<b>PRE-S-3 (10-12)</b>	<b>PRE-W-4</b>	<b>PRE-W-5</b>
2,3,7,8-Tetrachlorodibenzo(p)dioxin	560	60	290	670 U
1,2,3,7,8-Pentachlorodibenzo(p)dioxin	3,700	40	2,000	4,500 U
1,2,3,4,7,8-Hexachlorodibenzo(p)dioxin	7,700	70 J	4,100	6,400
1,2,3,6,7,8-Hexachlorodibenzo(p)dioxin	9,400	80 J	4,800	10,600
1,2,3,7,8,9-Hexachlorodibenzo(p)dioxin	9,400	80 J	5,000	11,000
1,2,3,4,6,7,8-Heptachlorodibenzo(p)dioxin	60,000	840 J	31,000	66,000
Octachlorodibenzo(p)dioxin	75,000	2,500 J	39,000	78,000
2,3,7,8-Tetrachlorodibenzofuran	36,000	2,500 U	82,000	81,000
1,2,3,7,8-Pentachlorodibenzofuran	148,000	16,200	300,000	500,000
2,3,4,7,8-Pentachlorodibenzofuran	48,000	1,100	24,000	57,000
1,2,3,4,7,8-Hexachlorodibenzofuran	200,000	16,100	490,000	440,000 J
1,2,3,6,7,8-Hexachlorodibenzofuran	104,000	11,400	280,000	270,000 J
2,3,4,6,7,8-Hexachlorodibenzofuran	80,000	3,100	43,000	69,000 J
1,2,3,7,8,9-Hexachlorodibenzofuran	84,000	3,200	47,000	86,000 J
1,2,3,4,6,7,8-Heptachlorodibenzofuran	340,000	27,000 U	860,000	780,000
1,2,3,4,7,8,9-Heptachlorodibenzofuran	180,000	19,400	560,000	390,000
Octachlorodibenzofuran	2,800,000	245,000	8,500,000	13,700,000
Total tetrachlorodibenzo(p)dioxins	43,000	610	25,000	46,000
Total pentachlorodibenzo(p)dioxins	51,000	770	24,000	53,000
Total hexachlorodibenzo(p)dioxins	117,000	880	60,000	139,000
Total heptachlorodibenzo(p)dioxins	109,000	840	61,000	132,000
Total tetrachlorodibenzofurans	270,000	30,000	870,000	1,180,000
Total pentachlorodibenzofurans	380,000	61,000	1,220,000	1,810,000
Total hexachlorodibenzofurans	540,000	56,000	1,520,000	1,390,000
Total heptachlorodibenzofurans	680,000	27,000	1,830,000	1,530,000

Notes:

- J = The analyte was detected. The reported numerical value is considered to be estimated for quality control reasons.  
 U = The analyte was not detected. The reported numerical value is the sample quantitation limit.

**TABLE 3**

**SUMMARY OF VALIDATED ANALYTICAL RESULTS FROM SDG NO. 54787**  
(nanograms per kilogram)

<b>Sample Location:</b>	<b>PRE-S-2 (0-2)</b>	<b>PRE-S-2 (10-12)</b>	<b>PRE-W-2</b>	<b>PRE-W-201<sup>a</sup></b>	<b>PRE-W-202<sup>a</sup></b>	<b>PRE-W-3</b>
2,3,7,8-Tetrachlorodibenzo(p)dioxin	18.9 U	190	1,200 U	600 U	1,800 U	2,000 J
1,2,3,7,8-Pentachlorodibenzo(p)dioxin	119 J	1,350	8,300 J	5,200 J	2,100 U	14,100
1,2,3,4,7,8-Hexachlorodibenzo(p)dioxin	198 U	2,300	13,900	9,800 J	8,400 J	71,000
1,2,3,6,7,8-Hexachlorodibenzo(p)dioxin	270	3,500	21,000	12,500	10,100	45,000
1,2,3,7,8,9-Hexachlorodibenzo(p)dioxin	240	3,300	19,100 U	10,200	6,300 J	33,000
1,2,3,4,6,7,8-Heptachlorodibenzo(p)dioxin	1,900	23,000	106,000	65,000	51,600 U	420,000
Octachlorodibenzo(p)dioxin	4,200	43,000	257,000	146,000	156,000	910,000
2,3,7,8-Tetrachlorodibenzofuran	4,400	27,000	73,000	32,000	32,000	94,000
1,2,3,7,8-Pentachlorodibenzofuran	14,700	146,000	720,000	480,000	390,000	1,550,000
2,3,4,7,8-Pentachlorodibenzofuran	1,420	16,100	57,000	37,000	30,000	73,000
1,2,3,4,7,8-Hexachlorodibenzofuran	20,000	250,000	1,340,000	900,000	860,000	1,330,000
1,2,3,6,7,8-Hexachlorodibenzofuran	10,000	176,000	650,000	480,000	430,000	1,620,000
2,3,4,6,7,8-Hexachlorodibenzofuran	3,900	32,210	195,000	142,000	109,000	290,000
1,2,3,7,8,9-Hexachlorodibenzofuran	3,100	33,000	164,000	115,000	59,000	330,000
1,2,3,4,6,7,8-Heptachlorodibenzofuran	36,000	490,000	2,200,000	1,550,000	1,480,000	2,400,000
1,2,3,4,7,8,9-Heptachlorodibenzofuran	26,000	183,000	1,240,000	880,000	690,000	3,900,000
Octachlorodibenzofuran	480,000	4,500,000	24,000,000	19,600,000	14,200,000	24,000,000
Total tetrachlorodibenzo(p)dioxins	290	16,700	31,000	48,000	36,000	109,000
Total pentachlorodibenzo(p)dioxins	730	28,000	133,000	73,000	60,000	240,000
Total hexachlorodibenzo(p)dioxins	2,300	41,000	210,000	140,000	128,000	720,000
Total heptachlorodibenzo(p)dioxins	3,200	41,000	191,000	119,000	51,000	680,000
Total tetrachlorodibenzofurans	26,000	500,000	1,890,000	1,160,000	1,070,000	2,300,000
Total pentachlorodibenzofurans	50,000	730,000	2,700,000	1,880,000	1,700,000	5,700,000

**TABLE 3 (Continued)**

**SUMMARY OF VALIDATED ANALYTICAL RESULTS FROM SDG NO. 54787**  
(nanograms per kilogram)

<b>Sample Location:</b>	<b>PRE-S-2 (0-2)</b>	<b>PRE-S-2 (10-12)</b>	<b>PRE-W-2</b>	<b>PRE-W-201<sup>a</sup></b>	<b>PRE-W-202<sup>a</sup></b>	<b>PRE-W-3</b>
Total hexachlorodibenzofurans	63,000	770,000	3,600,000	2,700,000	2,500,000	4,100,000
Total heptachlorodibenzofurans	79,000	910,000	4,600,000	3,200,000	2,800,000	5,000,000

Notes:

a Field replicate of sample PRE-W-2

J = The analyte was detected. The reported numerical value is considered to be estimated for quality control reasons.

U = The analyte was not detected. The reported numerical value is the sample quantitation limit.

**TABLE 4**  
**SUMMARY OF TOXICITY EQUIVALENTS**  
(nanograms per kilogram)

Sample	Toxicity Equivalents		
	Maximum <sup>a</sup>	Minimum <sup>b</sup>	Median <sup>c</sup>
PRE-S-1 (0-2)	3,750	3,450	3,600
PRE-S-1 (10-12)	313,000	313,000	313,000
PRE-W-1	586,000	577,000	581,000
PRE-W-6	430,000	430,000	430,000
PRE-S-3 (0-2)	95,700	95,700	95,700
PRE-S-3 (10-12)	5,890	5,370	5,630
PRE-W-4	147,400	147,400	147,400
PRE-W-5	179,900	177,000	178,400
PRE-S-2 (0-2)	6,890	6,850	6,870
PRE-S-2 (10-12)	80,200	80,200	80,200
PRE-W-2	378,000	374,000	376,000
PRE-W-201 <sup>d</sup>	260,000	260,000	260,000
PRE-W-202 <sup>d</sup>	226,000	222,000	224,000
PRE-W-3	596,000	596,000	596,000

Notes:

- a "Maximum" calculated with nondetect results assumed to be equal to the sample reporting limits
- b "Minimum" calculated with nondetect results assumed to be zero
- c "Median" calculated with nondetect results assumed to be half the sample reporting limits
- d Field replicates of sample PRE-W-2

January 15, 2003

Memo to: ISTD File  
From: Harry Ellis  
Re: Data Validation for Post-Demonstration Samples (All Analyses)

This memorandum documents a data validation of the analytical results from soil samples collected during the post-demonstration sampling for the In Situ Thermal Destruction (ISTD) Technology carried out at the "Hex Pit" of the Rocky Mountain Arsenal, Adams County, Colorado, under the auspices of the U.S. Environmental Protection Agency (EPA) Field Evaluation and Technical Support (FEATS) program by Tetra Tech EM Inc. (Tetra Tech) and its subcontractor, Kemron Environmental Services (Kemron). A total of 14 soil samples were collected by Tetra Tech on October 15 through 17, 2002. These were sent by overnight courier to Accura Analytical Laboratory (AAL) of Norcross, Georgia. AAL analyzed the samples as sample delivery group (SDG) No. 2846. The seven grab samples were analyzed by EPA Test Methods for Evaluating Solid Wastes (SW-846) Method 8260B for volatile organic compounds (VOC). AAL analyzed the seven composite samples for semivolatile organic compounds (SVOC) by SW-846 Method 8270C and for organochlorine pesticides by SW-846 Method 8081A. About a week after sample collection, AAL also analyzed the composite samples for pH by SW-846 Method 9045C. Tetra Tech also sent portions of the composite samples to Triangle Laboratories, Inc. (Triangle), of Durham, North Carolina. Triangle analyzed the samples for polychlorinated dibenzo(p)dioxins and polychlorinated dibenzofurans (dioxins) by SW-846 Method 8290, under SDG No. 58676.

The data were evaluated in general accordance with the EPA Contract Laboratory Program National Functional Guidelines (NFG) for organic data review, dated October 1999, and the draft NFG for dioxin data review, dated August 2002. The various methods provide guidance on procedures and method acceptance criteria that, in some cases, differ from those in the NFG. When differences exist between the methods and the NFG, the data validation followed the acceptance criteria given in the methods. In addition, if the data package presented laboratory-specific acceptance criteria, then these criteria were used to evaluate the data unless the criteria were considered inadequate. Finally, in cases where the criteria in Section 6.0 of the quality assurance project plan (QAPP) are different from the others, the QAPP criteria are used in the validation. The evaluation of the data was based on the following parameters:

- Data package completeness
- Holding times
- Instrument performance check

- Initial and continuing calibrations
- Blanks
- Matrix spike/matrix spike duplicate (MS/MSD) analyses
- Laboratory control samples (LCS)
- Internal standards
- Surrogate recoveries
- Compound quantitation

The following sections discuss, in turn, the analyses for VOCs, SVOCs, organochlorine pesticides, pH, and dioxins. A final section provides an overall evaluation of the analyses and is followed by an attachment containing a series of tables summarizing the validated analytical results

## **1.0 VOLATILE ORGANIC COMPOUND ANALYSES**

The VOC analyses had no problems with data package completeness, holding times, instrument performance check, LCS results, internal standards, and surrogate recoveries. Validated results are on Table 1 of the attachment.

In the VOC initial calibrations, some analytes had an average relative response factor (RRF) less than the usual data validation minimum of 0.05. Accura compensated for this by using appropriately higher quantitation limits for these compounds, so no qualifications are warranted. In the continuing calibration performed before most of the sample analytical runs, the RRF for 1,2,3-trichlorobenzene, 1,2,4-trichlorobenzene, 1,4-dioxane, and acetone had an excessive percent difference (over 25 percent) from the average RRF from the initial calibration. Therefore, all results for those compounds from the associated runs are flagged “J” or “UJ,” as appropriate, to indicate that they are estimated. In the last continuing calibration, acrolein had an excessive percent difference. Since all acrolein results are derived from earlier analyses, no qualifications are warranted.

VOC blanks contained traces of chloromethane and xylenes. Similar low concentrations in some samples are flagged “U” to indicate that they are considered to be artifacts.

The MS/MSD analyses were performed using sample POST-HVJ6. That sample was diluted so much to bring the major contaminants within calibration range in the parent sample that spike recoveries could not

be reliably determined. However, the precision results (relative percent differences between the two spiked sample results) were acceptable. No qualifications are warranted for the missing data.

Accura found it difficult to bring all positive results within the calibration range, despite the use of multiple dilutions and both low-level and medium-level analytical procedures. Table 1 (in the attachment) reflects the best available results. When a concentration from the least diluted chromatographic run is below the calibration range (such as 1,1-dichloroethane, 1,2,3-trichlorobenzene, and other compounds in sample POST-HVH4), that extrapolation is flagged “J” to indicate that it is estimated.

Carbon tetrachloride and chloroform in sample POST-HVJ6 are illustrative examples of inconsistent results. Although the upper end of the calibration range is 20 times the lower end, the results for those compounds exceed the range in the undiluted run but are below it in the 5-fold diluted run. This may be a consequence of a highly variable distribution of contaminants within the sample. The tabulated results are those from the undiluted run and are flagged “J” to indicate that they are estimated.

## **2.0 SEMIVOLATILE ORGANIC COMPOUND ANALYSES**

The SVOC analyses had no problems with data package completeness, holding times, instrument performance check, LCS results, and internal standards. Validated results are summarized in Table 2 of the attachment.

All initial calibration results were within QC limits. One continuing calibration had an excessive percent difference for 2,4-dinitrophenol. The sample quantitation limits for that compound are flagged “UJ” to indicate that they are estimated. The other continuing calibration had an excessive percent difference for pentachlorophenol. Since all results for that compound were associated with the first continuing calibration, no further qualifications are warranted.

The laboratory blank contained traces of hexachlorocyclopentadiene and several polynuclear aromatic hydrocarbons (PAH). The samples contained much more hexachlorocyclopentadiene but none of the PAHs, so no qualifications are required.

As with the VOC analyses, sample POST-HVJ6 was used for MS/MSD analyses and recoveries could not be calculated due to the excessive dilution of the sample required to bring contaminants within calibration range. The precision results were all acceptable. No qualifications will be applied for the data gaps.

Surrogate recoveries could not be determined in many analytical runs because of the high dilution factors. In the less diluted runs, most surrogate recoveries were within Accura's limits. However, two of the three acidic surrogates in the less diluted analytical run of sample POST-HVH8 were below their limits. Therefore, the results for all acidic analytes in that sample are flagged "UJ" to indicate that the quantitation limits are estimated, biased low.

As with the VOC analyses, samples were analyzed at multiple dilutions. The positive results below the calibration range in the least diluted run are flagged "J" to indicate that they are estimated.

### **3.0 ORGANOCHLORINE PESTICIDE ANALYSES**

The organochlorine pesticide analyses had no problems with data package completeness, holding times, instrument performance check, blanks, and LCS results. The method uses no internal standard. Validated results are summarized in Table 3 in the attachment.

All initial calibration results met QC requirements. A number of compounds had an excessive percent difference on the primary column or the secondary column, but not both, during the continuing calibrations. No qualifications are warranted for these irregularities. However, delta-BHC had differences above the QC limit of 15 percent on both columns during the closing continuing calibration. The results for that compound are flagged "UJ" to indicate that they are estimated.

No MS/MSD analyses were performed. In view of the results from the SVOC analyses, it is probable that such analyses would have provided little, if any, useful information. No qualifications will be applied for this data gap.

Due to the high dilution factor required by the presence of large amounts of various organochlorine compounds in the samples, surrogate recoveries could not be determined. No qualifications are warranted for these data gaps.

As with other analyses, some positive results, such as endrin ketone in sample POST-HVH8, were below the calibration range in the least diluted analysis. These extrapolations are flagged “J” to indicate that they are estimated. A number of other results, such as aldrin and endrin in that same sample, had relatively high differences between the results on the primary and secondary columns. These irregularities may be a result of varying amounts of nontarget compounds eluting with the analytes. All such results are flagged “J” to indicate that they are estimated.

#### **4.0 pH ANALYSES**

The pH analyses had no problems with data package completeness, calibration, and sample duplicate results. The only other QC parameter relevant to these analyses is sample quantitation. The instrument was calibrated with standard buffers over the range of 4 to 10. However, all sample results were at least 2 standard units outside this range. Therefore, the validated results, listed on Table 3 in the attachment, are flagged “J” to indicate that these extrapolations are estimated.

#### **5.0 POLYCHLORINATED DIBENZO(P)DIOXIN AND POLYCHLORINATED DIBENZOFURAN ANALYSES**

The dioxin analyses had no problems with holding times, instrument performance checks, initial and continuing calibrations, LCS and LCS duplicate analyses, internal standards, and surrogate recoveries. Validated analytical results are summarized in Table 4.

As received, the data package was missing two pages, the results summary for one sample. The data were available elsewhere, in both the raw data and the introductory data summary. Triangle furnished copies of the pages when requested.

The laboratory (method) blank and the cleanup blank contained low-level concentrations of several of the more chlorinated analytes. The samples contained much higher concentrations, so no qualifications are warranted.

MS/MSD analyses were performed on sample POST-HVJ6. For most analytes, the sample contained so much more compound than the spike that recoveries could not be reliably measured. Even for 2,3,7,8-tetrachlorodibenzo(p)dioxin (TCDD), which was not reported in the unspiked sample, the interfering material dominated analytical results. Therefore, there is no sample-specific information on accuracy. In

addition, precision results were not satisfactory since the MSD sample contained more of every analyte than the MS sample. These results are probably due to a heterogeneous distribution of the analytes within the material collected for the sample. All results for the parent sample are flagged "J" or "UJ" to indicate that they are estimated due to sample heterogeneity.

The initial analyses of these samples used the undiluted extracts. Most, if not all, of the analytes in every sample were above the calibration range, with many being high enough to saturate the detector. Triangle then reanalyzed all samples at a 100-fold dilution. In six of the seven sample extracts, one or more analytes still exceeded the calibration range, so these were reanalyzed at a 1000-fold dilution. Even then, the octachlorodibenzofuran (OCDF) concentration in four samples still exceeded calibration range. Further dilutions are not practical, since the internal standards would be difficult to separate cleanly from other material. Most tabulated results (Table 4) are derived from the 100-fold dilution. Some low concentration results (primarily TCDD) come from the original, undiluted analyses. The 1000-fold dilution results are used for the highest concentrations. The OCDF results that were extrapolated beyond the calibration range are flagged "J" to indicate that they are estimated.

The few nondetected results have rather high quantitation limits. All samples contained compounds that eluted in the same range as some target analytes. These peaks failed the ion abundance ratio criteria (for number of chlorine atoms per molecule), had the characteristics of polychlorinated diphenyl ethers, or both, and were deemed to be nondetected results. However, the presence of these extraneous peaks means that the sample quantitation limits, what the method calls "estimated maximum possible concentrations" which are calculated from the interferent concentrations, are therefore relatively high.

Table 5 summarizes the total toxicity equivalents of the samples. A sample containing 2,3,7,8-TCDD at a listed concentration on the table and none of the other target analytes would have the same toxic effects as a sample with several positives because 2,3,7,8-TCDD has a toxicity equivalent factor of 1.00. When one or more analytes has nondetected results, there are many possible assumptions one could make about the actual concentration, and therefore many possible toxicity equivalent estimates. The table shows the results of the three most common assumptions. The "maximum" values are based on the assumption that the nondetected results are equal to the sample reporting limits. The "minimum" values are based on the assumption that the nondetected results are actually zero. The "median" values are based on the assumption that the nondetected results are half the sample reporting limits. Risk assessment usually uses the "median" values. When there are no nondetected results, as is the case for most samples, the three

toxicity equivalent values are identical. When there are few nondetected results, as in the other samples, the differences are small.

## 6.0 OVERALL EVALUATION

These analyses went as well as could be expected, given the nature of the analytical methods and the samples. The methods (except for the pH method) are designed to identify and quantitate extremely low concentrations of organic compounds in relatively uncontaminated matrices of soil minerals. The samples, accurately labeled “nasty” by Accura’s preparation chemist, have low to high concentrations of many organic compounds, mostly chlorinated compounds. The collision between those characteristics produced many failures of QC measures. The matrix interferences seen in these samples can produce both false positives and false negatives and did produce extremely high sample quantitation limits in many cases. As a result, all of the quantitative results are somewhat uncertain, although not all have been formally qualified in the tables in the attachment.

All the samples have similar sorts of matrix interference, so the relative degrees of contamination are probably accurate. With these caveats, the validated results can be used, as qualified, for any purpose.

One notable aspect of these analyses is evidence of heterogeneity within samples, seen especially in the VOC and dioxin analyses. This adds to the uncertainty caused by the matrix interferences. Therefore, it would be difficult to compare these analytical results to the pre-demonstration results. A 10-fold difference in a parameter would represent a definite change. However, a lesser difference may only represent sample heterogeneity and analytical variation.

Since all samples were taken from borings in a single disposal unit, it is anticipated that all pH results would be either acidic or basic. Therefore the observed situation, with five highly acidic samples and two highly basic samples, is rather surprising. However, a review of the post-demonstration sampling borehole logs indicates that thick layers of probable lime material occurred in the borings producing the highly basic samples. In addition, there are differences in the organic chemistry of the two sets of samples. As shown in Tables 2, 4, and 5, the basic samples have much lower concentrations (usually one or more orders of magnitude) of SVOCs and dioxins than the acidic samples. The extreme differences in pH should be considered real.

The most unexpected part of this demonstration was finding that the stainless steel tubing and well points installed in the contaminated soil were practically destroyed. In chemical terms, at least one component of the iron-chromium-minor metals alloy was oxidized and then dissolved. All of the soil samples exhibited extreme pH values, either acidic or basic. Most commonly used oxidizing agents, including nitrate, sulfate, and perchlorate, are active in acidic conditions. A few, such as peroxide, are active in basic conditions. And a few, including both hypochlorite and elemental chlorine, are active at both pH extremes. The presence of suitable inorganic oxidants, of which hypochlorite is the one most likely to be associated with the wastes in the Hex Pit, plus the observed pH conditions, would be adequate to explain the dissolution of the metal.

**TABLE 1**

**SUMMARY OF VALIDATED VOLATILE ORGANIC COMPOUND ANALYTICAL RESULTS**  
(micrograms per kilogram)

<b>Sample Location:</b>	<b>POST-HVH4</b>	<b>POST-HVP4</b>	<b>POST-HVL4</b>	<b>POST-HVL401<sup>a</sup></b>	<b>POSTHVJ6</b>	<b>POST-HVH8</b>	<b>POST-HVP8</b>
<b>Depth (feet):</b>	<b>12.6</b>	<b>7.8</b>	<b>8.5</b>	<b>8.5</b>	<b>8.7</b>	<b>8.8</b>	<b>7.5</b>
1,1,1,2-Tetrachloroethane	3.7 U	300 U	270 U	3.9 U	8.9 U	7.6 U	3.6 U
1,1,1-Trichloroethane	3.7 U	300 U	270 U	3.9 U	8.9 U	7.6 U	3.6 U
1,1,2,2-Tetrachloroethane	3.7 U	300 U	160 J	3.9 U	8.9 U	7.6 U	3.6 U
1,1,2-Trichloroethane	3.7 U	300 U	110 J	3.9 U	3.1 J	7.6 U	2.4 J
1,1-Dichloroethane	0.54 J	300 U	270 U	3.9 U	1.9 J	7.6 U	3.6 U
1,1-Dichloroethene	3.7 U	300 U	270 U	3.9 U	8.9 U	7.6 U	3.6 U
1,1-Dichloropropene	3.7 U	300 U	270 U	3.9 U	8.9 U	7.6 U	3.6 U
1,2,3-Trichlorobenzene	3.3 J	230 J	260 J	3.9 UJ	13 J	3.1 J	3.6 UJ
1,2,3-Trichloropropane	3.7 U	300 U	270 U	3.9 U	8.9 U	7.6 U	3.6 U
1,2,4-Trichlorobenzene	11 J	780	1,600	1.7 J	25 J	4.1 J	3.6 UJ
1,2,4-Trimethylbenzene	7.5	170 J	270 U	3.6 J	5.7 J	5.3 J	2.7 J
1,2-Dibromo-3-chloropropane	3.7 U	300 U	110 J	3.9 U	8.9 U	7.6 U	3.6 U
1,2-Dichlorobenzene	1.8 J	190 J	200 J	3.9 U	11	4.8 J	3.6 U
1,2-Dichloroethane	3.7 U	300 U	74 J	3.9 U	1.1 J	7.6 U	3.6 U
1,2-Dichloropropane	3.7 U	300 U	270 U	3.9 U	8.9 U	7.6 U	3.6 U
1,3,5-Trimethylbenzene	2.5 J	300 U	270 U	1.1 J	1.9 J	1.6 J	0.83 J
1,3-Dichlorobenzene	1.2 J	110 J	79 J	3.9 U	5.8 J	7.6 U	3.6 U
1,3-Dichloropropane	3.7 U	300 U	94 J	3.9 U	8.9 U	7.6 U	3.6 U
1,4-Dichlorobenzene	3.7 U	300 U	600	1.0 J	13	7.6 U	3.6 U
1,4-Dioxane	73 UJ	6,000 U	5,300 U	79 UJ	180 UJ	150 UJ	71 UJ
2,2-Dichloropropane	3.7 U	300 U	270 U	3.9 U	8.9 U	7.6 U	3.6 U
2-Butanone	25 J	3,000 U	2,700 U	2.9 U	47 J	19 J	4.7 J

TABLE 1 (Continued)

**SUMMARY OF VALIDATED VOLATILE ORGANIC COMPOUND ANALYTICAL RESULTS**  
(micrograms per kilogram)

Sample Location:	POST-HVH4	POST-HVP4	POST-HVL4	POST-HVL401 <sup>a</sup>	POSTHVJ6	POST-HVH8	POST-HVP8
Depth (feet):	12.6	7.8	8.5	8.5	8.7	8.8	7.5
2-Chlorotoluene	3.7 U	300 U	270 U	3.9 U	8.9 U	7.6 U	3.6 U
2-Hexanone	37 U	3,000 U	2,700 U	39 U	89 U	76 U	36 U
4-Chlorotoluene	3.7 U	300 U	270 U	3.9 U	8.9 U	7.6 U	3.6 U
4-Methyl-2-pentanone	37 U	3,000 U	2,700 U	39 U	89 U	76 U	36 U
Acetone	1,200	1,700 J	2,700 U	780	1,200	560 J	69 J
Acetonitrile	37 U	3,000 U	2,700 U	39 U	89 U	76 U	3.6 U
Acrolein	7.3 U	600 U	530 U	7.9 U	18 U	15 U	7.1 U
Acrylonitrile	7.3 U	600 U	270 J	7.9 U	18 U	15 U	7.1 U
Allyl chloride	3.7 U	300 U	270 U	3.9 U	8.9 U	7.6 U	3.6 U
Benzene	45	150 J	65 J	5.4	27	23	4.3
Bromobenzene	3.7 U	300 U	33 J	3.9 U	8.9 U	7.6 U	3.6 U
Bromochloromethane	3.7 U	300 U	270 U	3.9 U	8.9 U	7.6 U	3.6 U
Bromodichloromethane	3.7 U	300 U	270 U	3.9 U	8.9 U	7.6 U	3.6 U
Bromoform	3.7 U	300 U	110 J	3.9 U	8.9 U	7.6 U	3.6 U
Bromomethane	11	600 U	530 U	16	18 U	15 U	7.1 U
Carbon Disulfide	3.7 U	300 U	270 U	3.9 U	7.4 J	8.8	3.6 U
Carbon Tetrachloride	5,200	3,800	870	54	830 J	63	100
Chlorobenzene	5.3	170 J	57 J	3.9 U	9.4	2.2 J	0.73 J
Chloroethane	12	600 U	530 U	15	29	15 U	9.4
Chloroform	4,400	2,300	1,100	2,600	670 J	180	4,400
Chloromethane	24	200 J	410 J	60	47	15 U	7.1 U

TABLE 1 (Continued)

SUMMARY OF VALIDATED VOLATILE ORGANIC COMPOUND ANALYTICAL RESULTS  
(micrograms per kilogram)

Sample Location:	POST-HVH4	POST-HVP4	POST-HVL4	POST-HVL401 <sup>a</sup>	POSTHVJ6	POST-HVH8	POST-HVP8
Depth (feet):	12.6	7.8	8.5	8.5	8.7	8.8	7.5
cis-1,2-Dichloroethene	3.7 U	300 U	270 U	3.9 U	8.9 U	7.6 U	3.6 U
cis-1,3-Dichloropropene	3.7 U	300 U	270 U	3.9 U	8.9 U	7.6 U	3.6 U
Dibromochloromethane	3.7 U	300 U	71 J	3.9 U	8.9 U	7.6 U	3.6 U
Dibromomethane	3.7 U	300 U	90 J	3.9 U	8.9 U	7.6 U	3.6 U
Ethyl Methacrylate	3.7 U	300 U	140 J	3.9 U	8.9 U	7.6 U	3.6 U
Ethylbenzene	11	300 U	270 U	3.9 U	2.2 J	2.9 J	0.68 J
Hexachlorobutadiene	68	7,500	8,600	5.7	120	21	23
Iodomethane	3.7 U	300 U	270 U	3.9 U	8.9 U	7.6 U	3.6 U
Isobutanol	73 U	6,000 U	5,300 U	79 U	180 U	150 U	71 U
Isopropylbenzene	3.7 U	300 U	270 U	3.9 U	8.9 U	7.6 U	3.6 U
Isopropyltoluene	3.7 U	300 U	270 U	3.9 U	8.9 U	7.6 U	3.6 U
Methyl Methacrylate	3.7 U	300 U	150 J	3.9 U	8.9 U	7.6 U	3.6 U
Methyl tert-butyl ether	3.7 U	300 U	130 J	3.9 U	8.9 U	7.6 U	3.6 U
Methylacrylonitrile	37 U	3,000 U	1,500 J	39 U	89 U	76 U	36 U
Methylene chloride	15	78 J	110 J	30	130	100	9.6
Naphthalene	4.1	300 J	190 J	3.9 U	1.6 J	7.6 U	3.6 U
n-Butylbenzene	1.2 J	300 U	270 U	3.9 U	8.9 U	7.6 U	3.6 U
Pentachloroethane	3.7 U	300 U	270 U	3.9 U	8.9 U	7.6 U	3.6 U
Propionitrile	37 U	3,000 U	2,700 U	39 U	89 U	76 U	36 U
sec-Butylbenzene	3.7 U	300 U	270 U	3.9 U	8.9 U	7.6 U	3.6 U
Styrene	3.7 U	300 U	270 U	3.9 U	8.9 U	7.6 U	3.6 U

TABLE 1 (Continued)

**SUMMARY OF VALIDATED VOLATILE ORGANIC COMPOUND ANALYTICAL RESULTS**  
(micrograms per kilogram)

Sample Location:	POST-HVH4	POST-HVP4	POST-HVL4	POST-HVL401 <sup>a</sup>	POSTHVJ6	POST-HVH8	POST-HVP8
Depth (feet):	12.6	7.8	8.5	8.5	8.7	8.8	7.5
tert-Butylbenzene	3.7 U	300 U	270 U	3.9 U	8.9 U	7.6 U	3.6 U
Tetrachloroethene	3,700	2,500	1,400	28	100	55	90
Toluene	3.9	300 U	270 U	1.2 J	4.2 J	2.9 J	11
trans-1,2-Dichloroethene	3.7 U	300 U	270 U	3.9 U	8.9 U	7.6 U	3.6 U
trans-1,3-Dichloropropene	3.7 U	300 U	63 J	3.9 U	8.9 U	7.6 U	3.6 U
Trichloroethene	9.9	68 J	270 U	2.4 J	11	7.1 J	8.2
Trichlorofluoromethane	3.7 U	300 U	270 U	3.9 U	8.9 U	7.6 U	3.6 U
Vinyl acetate	73 U	300 U	270 U	79 U	8.9 U	7.6 U	3.6 U
Vinyl chloride	3.7 U	300 U	270 U	2.5 J	8.9 U	7.6 U	3.6 U
Xylenes (total)	47	130 J	270 U	3.9 U	11	15	3.6 U

Notes:

- J = The analyte was detected. The reported numerical value is considered to be estimated for quality control reasons.
- U = The analyte was not detected. The reported numerical value is the sample quantitation limit.
- UJ = The analyte was not detected. The reported sample quantitation limit is considered estimated for quality control reasons.
- a Field duplicate sample

**TABLE 2**

**SUMMARY OF VALIDATED SEMIVOLATILE ORGANIC COMPOUND ANALYTICAL RESULTS**  
(micrograms per kilogram)

<b>Sample Location:</b>	<b>POST-HVH4</b>	<b>POST-HVP4</b>	<b>POST-HVL4</b>	<b>POST-HVL401<sup>a</sup></b>	<b>POSTHVJ6</b>	<b>POST-HVH8</b>	<b>POST-HVP8</b>
<b>Depth (feet):</b>	<b>7.6 - 15.6</b>	<b>4.8 - 12.8</b>	<b>5.5 - 13.5</b>	<b>5.5 - 13.5</b>	<b>5.7 - 13.7</b>	<b>5.8 - 13.8</b>	<b>6 - 14</b>
1,1'-Biphenyl	270,000 U	1,100,000 U	1,100,000 U	1,000,000 U	120,000 U	390 J	2,700,000 U
1,2,4-Trichlorobenzene	270,000 U	1,100,000 U	1,100,000 U	1,000,000 U	120,000 U	1,400 J	2,700,000 U
1,2-Dichlorobenzene	270,000 U	1,100,000 U	1,100,000 U	1,000,000 U	120,000 U	6,100 U	2,700,000 U
1,3-Dichlorobenzene	270,000 U	1,100,000 U	1,100,000 U	1,000,000 U	120,000 U	6,100 U	2,700,000 U
1,4-Dichlorobenzene	270,000 U	1,100,000 U	1,100,000 U	1,000,000 U	120,000 U	6,100 U	2,700,000 U
1-Methylnaphthalene	270,000 U	1,100,000 U	1,100,000 U	1,000,000 U	120,000 U	6,100 U	2,700,000 U
2,3,4,6-Tetrachlorophenol	270,000 U	1,100,000 U	1,100,000 U	1,000,000 U	120,000 U	6,100 UJ	2,700,000 U
2,4,5-Trichlorophenol	270,000 U	1,100,000 U	1,100,000 U	1,000,000 U	120,000 U	6,100 UJ	2,700,000 U
2,4,6-Trichlorophenol	270,000 U	1,100,000 U	1,100,000 U	1,000,000 U	120,000 U	6,100 UJ	2,700,000 U
2,4-Dichlorophenol	270,000 U	1,100,000 U	1,100,000 U	1,000,000 U	120,000 U	6,100 UJ	2,700,000 U
2,4-Dimethylphenol	270,000 U	1,100,000 U	1,100,000 U	1,000,000 U	120,000 U	6,100 UJ	2,700,000 U
2,4-Dinitrophenol	1,300,000 UJ	5,500,000 UJ	5,300,000 UJ	5,200,000 UJ	600,000 UJ	30,000 UJ	13,000,000 UJ
2,4-Dinitrotoluene	270,000 U	1,100,000 U	1,100,000 U	1,000,000 U	120,000 U	6,100 U	2,700,000 U
2,6-Dinitrotoluene	270,000 U	1,100,000 U	1,100,000 U	1,000,000 U	120,000 U	6,100 U	2,700,000 U
2-Chloronaphthalene	270,000 U	1,100,000 U	1,100,000 U	1,000,000 U	120,000 U	6,100 U	2,700,000 U
2-Chlorophenol	270,000 U	1,100,000 U	1,100,000 U	1,000,000 U	120,000 U	6,100 UJ	2,700,000 U
2-Methylnaphthalene	270,000 U	1,100,000 U	1,100,000 U	1,000,000 U	120,000 U	6,100 U	2,700,000 U
2-Methylphenol	270,000 U	1,100,000 U	1,100,000 U	1,000,000 U	120,000 U	6,100 UJ	2,700,000 U
2-Nitroaniline	530,000 U	2,200,000 U	2,100,000 U	2,100,000 U	240,000 U	12,000 U	5,300,000 U
2-Nitrophenol	270,000 U	1,100,000 U	1,100,000 U	1,000,000 U	120,000 U	6,100 UJ	2,700,000 U
3,3'-Dichlorobenzidine	530,000 U	2,200,000 U	2,100,000 U	2,100,000 U	240,000 U	12,000 U	5,300,000 U
3,4-Dimethylphenol	530,000 U	2,200,000 U	2,100,000 U	2,100,000 U	240,000 U	12,000 UJ	5,300,000 U
3-Nitroaniline	530,000 U	2,200,000 U	2,100,000 U	2,100,000 U	240,000 U	12,000 U	5,300,000 U

TABLE 2 (Continued)

**SUMMARY OF VALIDATED SEMIVOLATILE ORGANIC COMPOUND ANALYTICAL RESULTS**  
(micrograms per kilogram)

Sample Location:	POST-HVH4	POST-HVP4	POST-HVL4	POST-HVL401 <sup>a</sup>	POSTHVJ6	POST-HVH8	POST-HVP8
Depth (feet):	7.6 - 15.6	4.8 - 12.8	5.5 - 13.5	5.5 - 13.5	5.7 - 13.7	5.8 - 13.8	6 - 14
4,6-Dinitro-2-methylphenol	1,300,000 U	5,500,000 U	5,300,000 U	5,200,000 U	600,000 U	30,000 UJ	13,000,000 U
4-Bromophenyl-phenyl ether	270,000 U	1,100,000 U	1,100,000 U	1,000,000 U	120,000 U	6,100 U	2,700,000 U
4-Chloro-3-methylphenol	270,000 U	1,100,000 U	1,100,000 U	1,000,000 U	120,000 U	6,100 UJ	2,700,000 U
4-Chloroaniline	270,000 U	1,100,000 U	1,100,000 U	1,000,000 U	120,000 U	6,100 U	2,700,000 U
4-Chlorophenyl-phenylether	270,000 U	1,100,000 U	1,100,000 U	1,000,000 U	120,000 U	6,100 U	2,700,000 U
4-Nitroaniline	530,000 U	2,200,000 U	2,100,000 U	2,100,000 U	240,000 U	12,000 U	5,300,000 U
4-Nitrophenol	530,000 U	2,200,000 U	2,100,000 U	2,100,000 U	240,000 U	12,000 UJ	5,300,000 U
Acenaphthene	270,000 U	1,100,000 U	1,100,000 U	1,000,000 U	120,000 U	6,100 U	2,700,000 U
Acenaphthylene	270,000 U	1,100,000 U	1,100,000 U	1,000,000 U	120,000 U	6,100 U	2,700,000 U
Acetophenone	270,000 U	1,100,000 U	1,100,000 U	1,000,000 U	120,000 U	6,100 U	2,700,000 U
Anthracene	270,000 U	1,100,000 U	1,100,000 U	1,000,000 U	120,000 U	6,100 U	2,700,000 U
Atrazine	270,000 U	1,100,000 U	1,100,000 U	1,000,000 U	120,000 U	6,100 U	2,700,000 U
Benzo(a)anthracene	270,000 U	1,100,000 U	1,100,000 U	1,000,000 U	120,000 U	6,100 U	2,700,000 U
Benzo(a)pyrene	270,000 U	1,100,000 U	1,100,000 U	1,000,000 U	120,000 U	6,100 U	2,700,000 U
Benzo(b)fluoranthene	270,000 U	1,100,000 U	1,100,000 U	1,000,000 U	120,000 U	6,100 U	2,700,000 U
Benzo(g,h,i)perylene	270,000 U	1,100,000 U	1,100,000 U	1,000,000 U	120,000 U	6,100 U	2,700,000 U
Benzo(k)fluoranthene	270,000 U	1,100,000 U	1,100,000 U	1,000,000 U	120,000 U	6,100 U	2,700,000 U
Benzoic acid	1,300,000 U	5,500,000 U	5,300,000 U	5,200,000 U	600,000 U	30,000 UJ	13,000,000 U
Benzyl alcohol	270,000 U	1,100,000 U	1,100,000 U	1,000,000 U	120,000 U	6,100 U	2,700,000 U
Benzylbutylphthalate	270,000 U	1,100,000 U	1,100,000 U	1,000,000 U	120,000 U	6,100 U	2,700,000 U
bis(2-Chloroethoxy)methane	270,000 U	1,100,000 U	1,100,000 U	1,000,000 U	120,000 U	6,100 U	2,700,000 U
bis(2-Chloroethyl)ether	270,000 U	1,100,000 U	1,100,000 U	1,000,000 U	120,000 U	6,100 U	2,700,000 U

TABLE 2 (Continued)

**SUMMARY OF VALIDATED SEMIVOLATILE ORGANIC COMPOUND ANALYTICAL RESULTS**  
(micrograms per kilogram)

Sample Location:	POST-HVH4	POST-HVP4	POST-HVL4	POST-HVL401 <sup>a</sup>	POSTHVJ6	POST-HVH8	POST-HVP8
Depth (feet):	7.6 - 15.6	4.8 - 12.8	5.5 - 13.5	5.5 - 13.5	5.7 - 13.7	5.8 - 13.8	6 - 14
bis(2-Chloroisopropyl)ether	270,000 U	1,100,000 U	1,100,000 U	1,000,000 U	120,000 U	6,100 U	2,700,000 U
bis(2-Ethylhexyl)phthalate	270,000 U	1,100,000 U	88,000 J	1,000,000 U	120,000 U	6,100 U	2,700,000 U
Caprolacram	270,000 U	1,100,000 U	1,100,000 U	1,000,000 U	120,000 U	6,100 U	2,700,000 U
Chrysene	270,000 U	1,100,000 U	1,100,000 U	1,000,000 U	120,000 U	6,100 U	2,700,000 U
Dibenz(a,h)anthracene	270,000 U	1,100,000 U	1,100,000 U	1,000,000 U	120,000 U	6,100 U	2,700,000 U
Dibenzofuran	270,000 U	1,100,000 U	1,100,000 U	1,000,000 U	120,000 U	6,100 U	2,700,000 U
Diethylphthalate	270,000 U	1,100,000 U	1,100,000 U	1,000,000 U	120,000 U	6,100 U	2,700,000 U
Dimethylphthalate	270,000 U	1,100,000 U	1,100,000 U	1,000,000 U	120,000 U	6,100 U	2,700,000 U
Di-n-butylphthalate	270,000 U	1,100,000 U	1,100,000 U	1,000,000 U	120,000 U	6,100 U	2,700,000 U
Di-n-octylphthalate	270,000 U	1,100,000 U	1,100,000 U	1,000,000 U	120,000 U	6,100 U	2,700,000 U
Fluoranthene	270,000 U	1,100,000 U	1,100,000 U	1,000,000 U	120,000 U	6,100 U	2,700,000 U
Fluorene	270,000 U	1,100,000 U	1,100,000 U	1,000,000 U	120,000 U	6,100 U	2,700,000 U
Hexachlorobenzene	2,300,000	2,400,000	7,400,000	6,400,000	740,000	42,000	4,300,000
Hexachlorobutadiene	56,000 J	1,100,000 U	1,100,000 U	1,000,000 U	120,000 U	3,400 J	2,700,000 U
Hexachlorocyclopentadiene	4,700,000	5,000,000	190,000 J	93,000 J	1,500,000	4,100 J	7,300,000
Hexachloroethane	270,000 U	1,100,000 U	1,100,000 U	1,000,000 U	120,000 U	6,100 U	2,700,000 U
Indeno(1,2,3-cd)pyrene	270,000 U	1,100,000 U	1,100,000 U	1,000,000 U	120,000 U	6,100 U	2,700,000 U
Isodrin	270,000 U	1,100,000 U	1,100,000 U	1,000,000 U	120,000 U	6,100 U	2,700,000 U
Isophorone	270,000 U	1,100,000 U	1,100,000 U	1,000,000 U	120,000 U	6,100 U	2,700,000 U
Methyl methanesulfonate	270,000 U	1,100,000 U	1,100,000 U	1,000,000 U	120,000 U	6,100 U	2,700,000 U
Naphthalene	270,000 U	1,100,000 U	1,100,000 U	1,000,000 U	120,000 U	6,100 U	2,700,000 U
Nitrobenzene	270,000 U	1,100,000 U	1,100,000 U	1,000,000 U	120,000 U	6,100 U	2,700,000 U

**TABLE 2 (Continued)**

**SUMMARY OF VALIDATED SEMIVOLATILE ORGANIC COMPOUND ANALYTICAL RESULTS**  
(micrograms per kilogram)

<b>Sample Location:</b>	<b>POST-HVH4</b>	<b>POST-HVP4</b>	<b>POST-HVL4</b>	<b>POST-HVL401<sup>a</sup></b>	<b>POSTHVJ6</b>	<b>POST-HVH8</b>	<b>POST-HVP8</b>
<b>Depth (feet):</b>	<b>7.6 - 15.6</b>	<b>4.8 - 12.8</b>	<b>5.5 - 13.5</b>	<b>5.5 - 13.5</b>	<b>5.7 - 13.7</b>	<b>5.8 - 13.8</b>	<b>6 - 14</b>
N-Nitrosodi-n-propylamine	270,000 U	1,100,000 U	1,100,000 U	1,000,000 U	120,000 U	6,100 U	2,700,000 U
N-Nitrosodiphenylamine	270,000 U	1,100,000 U	1,100,000 U	1,000,000 U	120,000 U	6,100 U	2,700,000 U
Pentachlorophenol	530,000 U	2,200,000 U	2,100,000 U	2,100,000 U	240,000 U	12,000 UJ	5,300,000 U
Phenanthrene	270,000 U	1,100,000 U	1,100,000 U	1,000,000 U	120,000 U	6,100 U	2,700,000 U
Phenol	270,000 U	1,100,000 U	1,100,000 U	1,000,000 U	120,000 U	6,100 UJ	2,700,000 U
Pyrene	270,000 U	1,100,000 U	100,000 J	1,000,000 U	120,000 U	6,100 U	2,700,000 U

Notes:

- J = The analyte was detected. The reported numerical value is considered to be estimated for quality control reasons.
- U = The analyte was not detected. The reported numerical value is the sample quantitation limit.
- UJ = The analyte was not detected. The reported sample quantitation limit is considered estimated for quality control reasons.
- a Field duplicate sample

**TABLE 3**

**SUMMARY OF VALIDATED ORGANOCHLORINE PESTICIDE AND pH ANALYTICAL RESULTS**  
(microgram per kilogram)

<b>Sample Location:</b>	<b>POST-HVH4</b>	<b>POST-HVP4</b>	<b>POST-HVL4</b>	<b>POST-HVL401<sup>a</sup></b>	<b>POSTHVJ6</b>	<b>POST-HVH8</b>	<b>POST-HVP8</b>
<b>Depth (feet):</b>	<b>7.6 - 15.6</b>	<b>4.8 - 12.8</b>	<b>5.5 - 13.5</b>	<b>5.5 - 13.5</b>	<b>5.7 - 13.7</b>	<b>5.8 - 13.8</b>	<b>6 - 14</b>
4,4'-DDD	14,000 U	14,000 U	14,000 U	14,000 U	16,000 U	16,000 U	14,000 U
4,4'-DDE	35,000 J	110,000	14,000 U	14,000 U	180,000 J	16,000 U	14,000 U
4,4'-DDT	14,000 U	14,000 U	14,000 U	14,000 U	16,000 U	16,000 U	14,000 U
Aldrin	21,000	14,000 U	14,000 U	14,000 U	16,000 U	68,000 J	14,000 U
alpha-BHC	14,000 U	14,000 U	14,000 U	14,000 U	16,000 U	16,000 U	14,000 U
alpha-Chlordane	14,000 U	14,000 U	14,000 U	14,000 U	16,000 U	16,000 U	14,000 U
beta-BHC	14,000 U	14,000 U	14,000 U	14,000 U	16,000 U	16,000 U	14,000 U
Chlordane (technical)	140,000 U	140,000 U	140,000 U	140,000 U	160,000 U	160,000 U	140,000 U
delta-BHC	14,000 UJ	14,000 UJ	14,000 UJ	14,000 UJ	16,000 UJ	16,000 UJ	14,000 UJ
Dieldrin	190,000	14,000 U	14,000 U	14,000 U	40,000	480,000	14,000 U
Endosulfan I	14,000 U	14,000 U	160,000	150,000	16,000 U	16,000 U	14,000 U
Endosulfan II	120,000	190,000	14,000 U	14,000 U	16,000 U	16,000 U	14,000 U
Endosulfan sulfate	14,000 U	14,000 U	14,000 U	14,000 U	16,000 U	16,000 U	14,000 U
Endrin	14,000 U	14,000 U	14,000 U	14,000 U	16,000 U	19,000 J	14,000 U
Endrin aldehyde	14,000 U	14,000 U	14,000 U	14,000 U	16,000 U	16,000 U	14,000 U
Endrin ketone	14,000 U	14,000 U	200,000 J	210,000 J	16,000 U	4,500 J	14,000 U
gamma-BHC (Lindane)	19,000	14,000 U	14,000 U	14,000 U	16,000 U	16,000 U	14,000 U
gamma-Chlordane	14,000 U	14,000 U	14,000 U	14,000 U	9,200 J	16,000 U	14,000 U
Heptachlor	14,000 U	14,000 U	14,000 U	14,000 U	7,400 J	16,000 U	14,000 U
Heptachlor epoxide	14,000 U	14,000 U	14,000 U	14,000 U	16,000 U	16,000 U	14,000 U
Methoxychlor	72,000 U	72,000 U	70,000 U	69,000 U	81,000 U	81,000 U	72,000 U
Toxaphene	720,000 U	720,000 U	700,000 U	690,000 U	810,000 U	810,000 U	720,000 U

**TABLE 3 (Continued)**

**SUMMARY OF VALIDATED ORGANOCHLORINE PESTICIDE AND pH ANALYTICAL RESULTS**  
(microgram per kilogram)

<b>Sample Location:</b>	<b>POST-HVH4</b>	<b>POST-HVP4</b>	<b>POST-HVL4</b>	<b>POST-HVL401<sup>a</sup></b>	<b>POSTHVJ6</b>	<b>POST-HVH8</b>	<b>POST-HVP8</b>
<b>Depth (feet):</b>	<b>7.6 - 15.6</b>	<b>4.8 - 12.8</b>	<b>5.5 - 13.5</b>	<b>5.5 - 13.5</b>	<b>5.7 - 13.7</b>	<b>5.8 - 13.8</b>	<b>6 - 14</b>
pH (standard units)	2.0 J	2.0 J	2.0 J	1.0 J	12 J	12 J	2.0 J

Notes:

- J = The analyte was detected. The reported numerical value is considered to be estimated for quality control reasons.
- U = The analyte was not detected. The reported numerical value is the sample quantitation limit.
- UJ = The analyte was not detected. The reported sample quantitation limit is considered estimated for quality control reasons.
- a Field duplicate sample

**TABLE 4**

**SUMMARY OF VALIDATED DIOXIN RESULTS**  
(nanograms per kilogram)

<b>Sample Location:</b>	<b>POST-HVH4</b>	<b>POST-HVP4</b>	<b>POST-HVL4</b>	<b>POST-HVL401<sup>a</sup></b>	<b>POSTHVJ6</b>	<b>POST-HVH8</b>	<b>POST-HVP8</b>
<b>Depth (feet):</b>	<b>7.6 - 15.6</b>	<b>4.8 - 12.8</b>	<b>5.5 - 13.5</b>	<b>5.5 - 13.5</b>	<b>5.7 - 13.7</b>	<b>5.8 - 13.8</b>	<b>6 - 14</b>
2,3,7,8-Tetrachlorodibenzo(p)dioxin	1,190	825 U	1,340	1,830	471 UJ	430	970
1,2,3,7,8-Pentachlorodibenzo(p)dioxin	9,500	11,200	23,000	28,000	11,400 J	3,700	5,400 U
1,2,3,4,7,8-Hexachlorodibenzo(p)dioxin	21,000	24,000	48,000	59,000	31,000 J	3,200	14,800
1,2,3,6,7,8-Hexachlorodibenzo(p)dioxin	25,000	23,000	58,000	73,000	74,000 J	5,900	16,000
1,2,3,7,8,9-Hexachlorodibenzo(p)dioxin	24,000	17,400	42,000	58,000	55,000 J	6,200	14,400
1,2,3,4,6,7,8-Heptachlorodibenzo(p)dioxin	197,000	167,000	380,000	490,000	540,000 J	18,700	140,000
Octachlorodibenzo(p)dioxin	440,000	340,000	710,000	880,000	740,000 J	11,000	280,000
2,3,7,8-Tetrachlorodibenzofuran	55,000	88,130	194,000	240,000	5,500 J	13,700	68,000
1,2,3,7,8-Pentachlorodibenzofuran	351,000	700,000	1,370,000	1,610,000	25,000 J	24,200	1,150,000
2,3,4,7,8-Pentachlorodibenzofuran	38,000	64,000	143,000	200,000	12,300 J	7,300	62,000
1,2,3,4,7,8-Hexachlorodibenzofuran	1,120,000	1,600,000	3,000,000	3,200,000	250,000 J	58,000	2,100,000
1,2,3,6,7,8-Hexachlorodibenzofuran	380,000	620,000	1,140,000	1,300,000	106,000 J	32,000	1,350,000
2,3,4,6,7,8-Hexachlorodibenzofuran	149,000	250,000	480,000	570,000	45,000 J	10,600	360,000
1,2,3,7,8,9-Hexachlorodibenzofuran	86,000	200,000	290,000	350,000	4,800 J	4,500 J	280,000
1,2,3,4,6,7,8-Heptachlorodibenzofuran	1,800,000	2,060,000	3,300,000	3,500,000	940,000 J	154,000	5,200,000
1,2,3,4,7,8,9-Heptachlorodibenzofuran	1,110,000	1,460,000	2,500,000	2,900,000	86,000 J	32,000	2,900,000
Octachlorodibenzofuran	46,500,000 J	38,100,000	57,000,000 J	64,000,000 J	4,100,000 J	270,000	79,000,000 J
Total tetrachlorodibenzo(p)dioxins	58,000	55,000	37,000	46,000	23,000 J	17,100	18,400
Total pentachlorodibenzo(p)dioxins	130,000	144,000	197,000	188,000	130,000 J	40,000	50,000
Total hexachlorodibenzo(p)dioxins	240,000	230,000	450,000	600,000	530,000 J	48,000	155,000
Total heptachlorodibenzo(p)dioxins	330,000	270,000	620,000	760,000	950,000 J	33,000	240,000
Total tetrachlorodibenzofurans	860,000	1,710,000	1,740,000	2,000,000	71,000 J	106,000	1,310,000

**TABLE 4 (Continued)**

**SUMMARY OF VALIDATED DIOXIN RESULTS**  
(nanograms per kilogram)

<b>Sample Location:</b>	<b>POST-HVH4</b>	<b>POST-HVP4</b>	<b>POST-HVL4</b>	<b>POST-HVL401<sup>a</sup></b>	<b>POSTHVJ6</b>	<b>POST-HVH8</b>	<b>POST-HVP8</b>
<b>Depth (feet):</b>	<b>7.6 - 15.6</b>	<b>4.8 - 12.8</b>	<b>5.5 - 13.5</b>	<b>5.5 - 13.5</b>	<b>5.7 - 13.7</b>	<b>5.8 - 13.8</b>	<b>6 - 14</b>
Total pentachlorodibenzofurans	1,330,000	2,700,000	4,300,000	5,000,000	290,000 J	148,000	3,600,000
Total hexachlorodibenzofurans	2,600,000	4,200,000	7,400,000	7,800,000	810,000 J	210,000	6,600,000
Total heptachlorodibenzofurans	3,940,000	4,800,000	7,900,000	8,700,000	1,180,000 J	230,000	10,000,000

Notes:

J = The analyte was detected. The reported numerical value is considered to be estimated for quality control reasons.

U = The analyte was not detected. The reported numerical value is the sample quantitation limit.

ng/kg = nanograms per kilogram

<sup>a</sup> Field duplicate sample

**TABLE 5**  
**SUMMARY OF TOXICITY EQUIVALENTS**  
(nanograms per kilogram)

Sample	Toxicity Equivalents		
	Maximum <sup>b</sup>	Minimum <sup>c</sup>	Median <sup>d</sup>
POST-HVH4	305,000	305,000	305,000
POST-HVP4	432,000	431,000	432,000
POST-HVL4	798,000	798,000	798,000
POSTHVL401 <sup>a</sup>	910,000	910,000	910,000
POST-HVJ6	62,000	62,000	62,000
POST-HVH8	18,600	18,600	18,600
POST-HVP8	675,000	673,000	674,000

Notes:

- a Field Duplicate Sample
- b "Maximum" calculated with nondetected results assumed to be equal to the sample reporting limit
- c "Minimum" calculated with nondetected results assumed to be zero
- d "Median" calculated with nondetected results assumed to be half the sample reporting limits