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September 2008

**Demonstration of Steam Injection/Extraction Treatment
of a DNAPL Source Zone at Launch Complex 34 in
Cape Canaveral Air Force Station**

Final Innovative Technology Evaluation Report

Appendix G: Quality Assurance/Quality Control Information

Appendix G.1 Investigating VOC Losses During Postdemonstration Soil Core Recovery and Soil Sampling

Field procedures for collecting soil cores and soil samples from the steam injection plot were modified in an effort to minimize VOC losses that can occur when sampling soil at elevated temperatures (Battelle, 2001). The primary modifications included: (1) additional personnel safety equipment, such as thermal-insulated gloves for core handling; (2) the addition of a cooling period to bring the soil cores to approximately 20°C before collecting samples; and (3) capping the core ends while the cores were cooling. Concerns were raised about the possibility that increased handling times during soil coring, soil cooling, and sample collection may result in an increase in VOC losses. An experiment was conducted using soil samples spiked with a surrogate compound to investigate the effectiveness of the field procedures developed for LC34 in minimizing VOC losses.

Materials and Methods

Soil cores were collected in a 2-inch diameter, 4-foot long acetate sleeve that was placed tightly inside a 2-inch diameter stainless steel core barrel. The acetate sleeve was immediately capped on both ends with a protective polymer covering. The sleeve was placed in an ice bath to cool the heated core to below ambient groundwater temperatures (approximately 20°C). The temperature of the soil core was monitored during the cooling process with a meat thermometer that was pushed into one end cap (see Figure G-1). Approximately 30 minutes was required to cool each 4-foot long, 2-inch diameter soil core from 50-95°C to below 20°C (see Figure G-2). Upon reaching ambient temperature, the core sleeve was then uncapped and cut open along its length to collect the soil sample for contaminant analysis (see Figure G-3).



FIGURE G-1. A soil core capped and cooling in an ice bath. The thermometer is visible in the end cap.

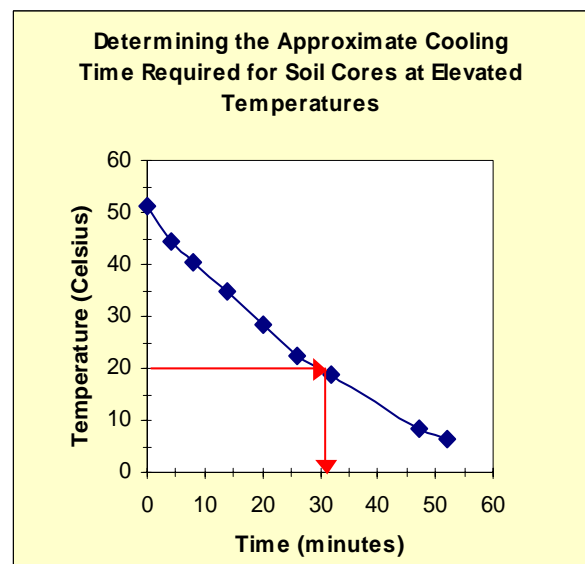


FIGURE G-2. Determining the length of time required to cool a soil core.



FIGURE G-3. A soil sample being collected from along the length of the core into a bottle containing methanol.

Soil samples were collected in relatively large quantities (approximately 200 g) along the entire length of the core rather than sampling small aliquots of the soil within the core, as required by the conventional method (EPA SW5035). This modification is advantageous because the resultant data provide an understanding of the continuous VOC distribution with depth. VOC losses during sampling were further minimized by placing the recovered soil samples directly into bottles containing methanol (approximately 250 mL) and extracting them on site. The extracted methanol was centrifuged and sent to an off-site laboratory for VOC analysis. The soil sampling and extraction strategy is described in more detail in Gavaskar et al. (2000).

To evaluate the efficiency of the sampling method in recovering VOCs, hot soil cores were extracted from 14 through 24 feet below ground surface and spiked with a surrogate compound, 1,1,1-trichloroethane (1,1,1-TCA). The surrogate was added to the intact soil core by using a 6" needle to inject 25 μL of surrogate into each end of the core for a total of 50 μL of 1,1,1-TCA. In order to evaluate the effect of the cooling period on VOC loss, three soil cores were spiked with TCA prior to cooling in the ice bath and three cores were spiked with TCA after cooling in the ice bath. In the pre-cooling test, the surrogate was injected as described above and the core barrels were subsequently capped and placed in the ice bath for the 30 minutes of cooling time required to bring the soil core to below 20°C. A thermometer was inserted through the cap to monitor the temperature of the soil core.

In the post-cooling test, the soil cores were injected with TCA after the soil core had been cooled in the ice bath to below 20°C. After cooling, the caps on the core barrel were removed and the surrogate compound was injected in the same manner, 25 μL per each end of the core barrel using a 6" syringe. The core was recapped and allowed to equilibrate for a few minutes before it was opened and samples were collected. Only for the purpose of the surrogate recovery tests, the entire contents of the sampling sleeve were collected and extracted on site with methanol. The soil:methanol ratio was kept approximately the same as during the regular soil sample collection and extraction. Several (four) aliquots of soil and several (four) bottles of methanol were required to extract the entire contents of the sample sleeve.

Two different capping methods were used during this experiment to evaluate the effectiveness of each cap type. Two of the soil cores were capped using flexible polymer sheets attached to the sleeve with rubber

bands. The remaining four soil cores were capped with tight-fitting rigid polymer end caps. One reason that the polymer sheets were preferred over the rigid caps was that the flexible sheets were better positioned to handle any contraction of the sleeve during cooling.

Results

The results from the surrogate spiking experiment are shown in Table G-1. Soil cores 1, 3, and 5 received the surrogate spike prior to cooling in the ice bath. Soil cores 2, 4, and 6 received the surrogate spike after cooling in the ice bath. The results show that between 84 and 113% of the surrogate spike was recovered from the soil cores. Recovery comparison is not expected to be influenced significantly by soil type because all samples were collected from a fine grained to medium fine-grained sand unit. The results also indicate that the timing of the surrogate spike (i.e., pre- or post-cooling) appeared to have only a slight effect on the amount of surrogate recovered. Slightly less surrogate was recovered from the soil cores spiked prior to cooling. This implies that any losses of TCA in the soil samples spiked prior to cooling are minimal and acceptable, within the limitations of the field sampling protocol. The field sampling protocol was designed to process up to 300 soil samples that were collected over a 3-week period, during each monitoring event.

Table G-1. Recovery in Soil Cores Spiked with 1,1,1-TCA Surrogate

Soil Cores Spiked <u>Prior to</u> Cooling	Capping Method	1,1,1-TCA Recovery (%)	Soil Cores Spiked <u>After</u> Cooling	Capping Method	1,1,1-TCA Recovery (%)
Core 1	Flexible polymer sheet with rubber bands	96.3	Core 2	Flexible polymer sheet with rubber bands	98.7
Core 3	Rigid End Cap	101.0	Core 4	Rigid End Cap	112.6
Core 5	Rigid End Cap	84.3	Core 6	Rigid End Cap	109.6

The capping method (flexible versus rigid cap) did not show any clear differences in the surrogate recoveries. The flexible sheets are easier to use and appear to be sufficient to ensure good target compound recovery.

This experiment demonstrates that the soil core handling procedures developed for use at LC34 were successful in minimizing volatility losses associated with the extreme temperatures of the soil cores. It also shows that collecting and extracting larger aliquots of soil in the field is a good way of characterizing DNAPL source zones.

References

- Battelle, 2001. *Quality Assurance Project Plan for Performance Evaluation of In-Situ Thermal Remediation System for DNAPL Removal at Launch Complex 34, Cape Canaveral, Florida*. Prepared by Battelle for Naval Facilities Engineering Service Center, June.
- Gavaskar, A., S. Rosansky, S. Naber, N. Gupta, B. Sass, J. Sminchak, P. DeVane, and T. Holdsworth. 2000. "DNAPL Delineation with Soil and Groundwater Sampling." Proceedings of the Second International Conference on Remediation of Chlorinated and Recalcitrant Compounds, Monterey, California, May 22-25. Battelle Press. 2(2): 49-58.

Table G-2. 1,1,1-TCA Surrogate Spike Recovery Values for Soil Samples Collected During the Steam Postdemonstration Sampling

Steam Treatment Plot: Extraction Efficiency Test					Total Number of Samples Collected = 312				
QA/QC Target Level Recovery % = 70 – 130 %					Total Number of Spiked Soil Samples Analyzed = 13				
QA/QC Target Level RPD < 30.0 %					Total Number of Spiked Methanol Blanks Analyzed = 13				
Steam Demonstration: 1,1,1-TCA Spiked Samples									
Sample ID	Sample Date	1,1,1-TCA Recovery (µg)	1,1,1-TCA Recovery (%)	RPD (%)	Sample ID	Sample Date	1,1,1-TCA Recovery (µg)	1,1,1-TCA Recovery (%)	RPD (%)
SB-231-2(SS)	1/30/02	1,575	118	4.4	SB-238-2(SS)	2/14/02	1,254	94	4.6
SB-231-MB(SS) ^(a)		1,509	113		SB-238-MB(SS)		1,315	98	
SB-232-2(SS)	1/29/02	1,337	100	4.0	SB-239-2(SS)	2/06/02	1,300	97	14.3
SB-232-MB(SS)		1,286	96		SB-239-MB(SS)		1,518	113	
SB-233-2(SS)	1/28/02	1,308	98	13.1	SB-240-2(SS)	2/04/02	1,073	80	3.5
SB-233-MB(SS)		1,504	112		SB-240-MB(SS)		1,112	83	
SB-234-2(SS)	2/13/02	1,220	91	5.8	SB-241-2(SS)	2/01/02	780	58	38.1
SB-234-MB(SS)		1,153	86		SB-241-MB(SS)		1,261	94	
SB-235-2(SS)	2/14/02	1,244	93	5.2	SB-242-2(SS)	1/30/02	1,082	81	8.5
SB-235-MB(SS)		1,182	88		SB-242-MB(SS)		1,182	88	
SB-236-2(SS)	2/12/02	1,324	99	1.8	SB-339-2(SS)	2/08/02	1,382	103	17.9
SB-236-MB(SS)		1,300	97		SB-339-MB(SS)		1,173	88	
SB-237-2(SS)	2/7/02	1,148	86	4.1	Range of Recovery in Soil Samples: 58-118% Average: 92%				
SB-237-MB(SS)			82						

(a) Samples listed as –MB are methanol blanks spiked with 1,1,1-TCA for the purpose of comparing to the amount of 1,1,1-TCA recovered from the soil samples.

Table G-3. Results and Precision of the Field Duplicate Samples Collected During the Predemonstration Soil Sampling

Steam Treatment Plot Field Duplicate Soil Samples QA/QC Target Level RPD < 30.0 %				Total Number of Soil Samples Collected = 302 (Predemonstration) Total Number of Field Duplicate Samples Analyzed = 13 (Predemonstration)			
Predemonstration							
Sample ID	Sample Date	Result (mg/kg)	RPD (%)	Sample ID	Sample Date	Result (mg/kg)	RPD (%)
SB-42-34	11/28/00	7,348	115.1 ^(a)	SB-34-30	12/02/00	208	4.1
SB-42-34 DUP		3,411		SB-34-30 DUP		217	
SB-41-28	11/28/00	394	1.3	SB-32-18	12/06/00	ND	0.0
SB-41-28 DUP		389		SB-32-18 DUP		ND	
SB-37-24	11/29/00	83	43.1 ^(b)	SB-33-22	12/07/00	46	17.9
SB-37-24 DUP		58		SB-33-22 DUP		39	
SB-40-36	11/29/00	73	58.7 ^(b)	SB-31-32	12/08/00	106	10.4
SB-40-36 DUP		46		SB-31-32 DUP		96	
SB-39-20	12/01/00	14	27.3 ^(b)	SB-36-16	12/11/00	ND	0.0
SB-39-20 DUP		11		SB-36-16 DUP		0.44	
SB-38-39	12/01/00	337	9.8	SB-41B-40	12/11/00	392	10.1
SB-38-39 DUP		307		SB-41B-40 DUP		356	
SB-35-24	12/02/00	11	63.3 ^(a)				
SB-35-24 DUP		30					

(a) Samples had high RPD values due to the presence of free-phase TCE, which significantly affected the RPD calculation.

(b) Samples had high RPD values due to the effect of low (or below detect) concentrations of TCE, which significantly affected the RPD calculation.

Table G-4. Results and Precision of the Field Duplicate Samples Collected During the Postdemonstration Soil Sampling

Steam Treatment Plot Field Duplicate Soil Samples QA/QC Target Level < 30.0 %				Total Number of Soil Samples Collected = 312 (Postdemonstration) Total Number of Field Duplicate Samples Analyzed = 15 (Postdemonstration)			
Postdemonstration							
Sample ID	Sample Date	Result (mg/kg)	RPD (%)	Sample ID	Sample Date	Result (mg/kg)	RPD (%)
SB-233-26	01/28/02	101	19.8	SB-237-16	02/07/02	1	0.0
SB-233-26 DUP		126		SB-237-16 DUP		1	
SB-232-34	01/29/02	560	12.2	SB-339-40	02/08/02	73	6.4
SB-232-34 DUP		499		SB-339-40 DUP		78	
SB-231-40	01/30/02	382	12.0	SB-236-20	02/12/02	4	33.3 ^(a)
SB-231-40 DUP		434		SB-236-20 DUP		3	
SB-242-38	01/30/02	1,451	24.4	SB-234-24	02/13/02	4	0.0
SB-242-38 DUP		1,920		SB-234-24 DUP		4	
SB-241-20	02/01/02	4	0.0	SB-234-26	02/13/02	7	36.4 ^(a)
SB-241-20 DUP		4		SB-234-26 DUP		11	
SB-240-38	02/04/02	124	13.7	SB-235-26	02/14/02	120	37.9 ^(a)
SB-240-38 DUP		109		SB-235-26 DUP		87	
SB-233-26	01/28/02	101	19.8	SB-238-20	02/15/02	20	39.4 ^(a)
SB-233-26 DUP		126		SB-238-20 DUP		33	
SB-239-24	02/06/02	10	23.1				
SB-239-24 DUP		13					

(a) Samples had high RPD values due to the effect of low (or below detect) concentrations of TCE, which significantly affected the RPD calculation.

Table G-5. Results of the Rinsate Blank Samples Collected During the Pre- and Post-Demonstration Soil Sampling

Total Number of Soil Samples Collected = 302 (Pre-) 312 (Post-)							
Total Number of Field Samples Analyzed = 27							
Pre-Demonstration Rinsate Blank Samples				Post-Demonstration Rinsate Blank Samples			
Sample ID	Sample Date	Result (µg/L)	Comments	Sample ID	Sample Date	Result (µg/L)	Comments
RINSATE-1	11/27/00	<1.0	Met QA/QC Target Criteria	SB-233-RINSATE	01/28/02	<1.0	Met QA/QC Target Criteria
RINSATE-2	11/28/00	<1.0	Met QA/QC Target Criteria	SB-232-RINSATE	01/29/02	<1.0	Met QA/QC Target Criteria
RINSATE-3	11/30/00	<1.0	Met QA/QC Target Criteria	SB-231-RINSATE	01/30/02	<1.0	Met QA/QC Target Criteria
RINSATE-4	11/30/00	<1.0	Met QA/QC Target Criteria	SB-242-RINSATE	01/30/02	<1.0	Met QA/QC Target Criteria
RINSATE-5	11/30/00	<1.0	Met QA/QC Target Criteria	SB-241-RINSATE	02/01/02	<1.0	Met QA/QC Target Criteria
RINSATE-6	12/01/00	<1.0	Met QA/QC Target Criteria	SB-240-RINSATE	02/04/02	<1.0	Met QA/QC Target Criteria
RINSATE-7	12/01/00	<1.0	Met QA/QC Target Criteria	SB-239-RINSATE	02/06/02	<1.0	Met QA/QC Target Criteria
RINSATE-8	12/04/00	<1.0	Met QA/QC Target Criteria	SB-237-RINSATE	02/07/02	<1.0	Met QA/QC Target Criteria
RINSATE-9	12/04/00	<1.0	Met QA/QC Target Criteria	SB-339-RINSATE	02/08/02	<1.0	Met QA/QC Target Criteria
RINSATE-10	12/07/00	<1.0	Met QA/QC Target Criteria	SB-236-RINSATE	02/12/02	<1.0	Met QA/QC Target Criteria
RINSATE-11	12/07/00	<1.0	Met QA/QC Target Criteria	SB-234-RINSATE	02/13/02	<1.0	Met QA/QC Target Criteria
RINSATE-12	12/08/00	<1.0	Met QA/QC Target Criteria	SB-235-RINSATE	02/14/02	<1.0	Met QA/QC Target Criteria
RINSATE-13	12/09/00	<1.0	Met QA/QC Target Criteria	SB-334-RINSATE	02/14/02	<1.0	Met QA/QC Target Criteria
				SB-238-RINSATE	02/15/02	<1.0	Met QA/QC Target Criteria

Table G-6. Results of the Methanol Blank Samples Collected During the Pre- and Post-Demonstration Soil Sampling

Steam Methanol Blank Soil Extraction QA/QC Samples QA/QC Target Level < 1.0 mg/kg				Total Number of Soil Samples Collected = 302 (Pre-) 312 (Post-) Total Number of Field Samples Analyzed = 30			
Pre-Demonstration Methanol Blank Samples				Post-Demonstration Methanol Blank Samples			
Sample ID	Sample Date	Result (mg/kg)	Comments	Sample ID	Sample Date	Result (mg/kg)	Comments
SB-42-62	11/28/00	<0.250	Met QA/QC Target Criteria	SB-233-MB	01/28/02	<0.250	Met QA/QC Target Criteria
SB-41-65	11/30/00	<0.250	Met QA/QC Target Criteria	SB-232-MB	01/29/02	<0.250	Met QA/QC Target Criteria
SB-34-64	11/30/00	<0.250	Met QA/QC Target Criteria	SB-231-MB	01/30/02	<0.250	Met QA/QC Target Criteria
SB-39-68	12/04/00	<0.250	Met QA/QC Target Criteria	SB-242-MB	01/30/02	<0.250	Met QA/QC Target Criteria
SB-38-67	12/04/00	<0.250	Met QA/QC Target Criteria	SB-241-MB	02/01/02	<0.250	Met QA/QC Target Criteria
SB-35-66	12/04/00	<0.250	Met QA/QC Target Criteria	SB-240-MB	02/04/02	<0.250	Met QA/QC Target Criteria
SB-32-69	12/06/00	<0.250	Met QA/QC Target Criteria	SB-239-MB	02/06/02	<0.250	Met QA/QC Target Criteria
SB-32-70	12/06/00	<0.250	Met QA/QC Target Criteria	SB-237-MB	02/07/02	<0.250	Met QA/QC Target Criteria
SB-33-71	12/07/00	<0.250	Met QA/QC Target Criteria	SB-339-MB	02/08/02	<0.250	Met QA/QC Target Criteria
SB-33-72	12/07/00	<0.250	Met QA/QC Target Criteria	SB-236-MB	02/12/02	<0.250	Met QA/QC Target Criteria
SB-31-73	12/08/00	<0.250	Met QA/QC Target Criteria	SB-234-MB	02/13/02	<0.250	Met QA/QC Target Criteria
SB-31-74	12/08/00	<0.250	Met QA/QC Target Criteria	SB-235-MB	02/14/02	<0.250	Met QA/QC Target Criteria
SB-36-78	12/11/00	<0.250	Met QA/QC Target Criteria	SB-238-MB	02/15/02	<0.250	Met QA/QC Target Criteria
SB-36-79	12/11/00	<0.250	Met QA/QC Target Criteria				
SB-41B-82	12/12/00	<0.250	Met QA/QC Target Criteria				
SB-41B-83	12/12/00	<0.250	Met QA/QC Target Criteria				

(a) Methanol Blank sample concentrations were below 10% of the TCE results for the samples in these batches. This batch included the following set of samples: SB-5-2 through SB-5-45

Table G-7. Results and Precision of the Field Duplicate Samples Collected During the Pre- and Post-Demonstration Groundwater Sampling

Steam Treatment Plot Field Duplicate Groundwater Samples QA/QC Target Level < 30.0 %				Total Number of Groundwater Samples Collected = 23 (Pre-) 21 (Post-) Total Number of Field Duplicate Samples Analyzed = 3			
Pre-Demonstration				Post-Demonstration			
Sample ID	Sample Date	Result (µg/L)	RPD (%)	Sample ID	Sample Date	Result (µg/L)	RPD (%)
PA-17D	11/29/00	840,000	2.3	PA-17D	03/25/02	2,770	3.6
PA-17D DUP		860,000		PA-17D DUP		2,680	
PA-13	11/28/00	920,000	1.1				
PA-13D DUP		910,000					

Table G-8. Results and Precision of the Field Duplicate Samples Collected During the Steam Demonstration Groundwater Sampling

Steam Treatment Plot Field Duplicate Groundwater Samples QA/QC Target Level < 30.0 %				Total Number of Groundwater Samples Collected = 33 Total Number of Field Duplicate Samples Analyzed = 4			
Demonstration							
Sample ID	Sample Date	Result (µg/L)	RPD (%)	Sample ID	Sample Date	Result (µg/L)	RPD (%)
BAT-5D	08/27/01	280,000	6.67	BAT-5S	11/22/01	532	10.6
BAT-5D DUP		300,000		BAT-5S DUP		595	
PA-22	08/28/01	1,000,000	0.0	PA-14S	11/23/01	4,280	2.9
PA-22 DUP		1,000,000		PA-14S DUP		4,410	

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Table G-9. Rinsate Blank Results for Groundwater Samples Collected for the Steam Pre-and Post-Demonstration Groundwater Sampling

Steam Pre-Demonstration Groundwater QA/QC Samples QA/QC Target Level < 3.0 µg/L			Total Number of Samples Collected = 23 (Pre-) 21 (Post-) Total Number of Rinsate Blank Samples Analyzed = 4		
Pre-Demonstration Rinsate Blanks			Post-Demonstration Rinsate Blanks		
Analysis Date	TCE Concentration (µg/L)	Comments	Analysis Date	TCE Concentration (µg/L)	Comments
11/28/00	<1.0	Met QA/QC Target Criteria	2/20/02	<1.0	Met QA/QC Target Criteria
11/29/00	<1.0	Met QA/QC Target Criteria	2/21/02	<1.0	Met QA/QC Target Criteria

Table G-10. Rinsate Blank Results for Groundwater Samples Collected for the Steam Demonstration Groundwater Sampling

Steam Demonstration Groundwater QA/QC Samples QA/QC Target Level < 3.0 µg/L			Total Number of Samples Collected = 33 Total Number of Rinsate Blank Samples Analyzed = 4		
Demonstration					
Analysis Date	TCE Concentration (µg/L)	Comments	Analysis Date	TCE Concentration (µg/L)	Comments
08/27/01	<1.0	Met QA/QC Target Criteria	11/20/01	<1.0	Met QA/QC Target Criteria
08/28/01	<1.0	Met QA/QC Target Criteria	11/21/01	<1.0	Met QA/QC Target Criteria

Table G-11. Results of the Trip Blank Samples Analyzed During the Steam Demonstration Soil and Groundwater Sampling

Total Number of Samples Collected = 614 (Soil) 77 (Groundwater) Total Number of Field Samples Analyzed = 20							
Steam Demonstration Trip Blanks							
Sample ID	Sample Date	Result (µg/L)	Comments	Sample ID	Sample Date	Result (µg/L)	Comments
Trip Blank-1	11/30/00	<1.0	Met QA/QC target criteria.	Trip Blank-11	11/06/01	<1.0	Met QA/QC target criteria.
Trip Blank-2	12/01/00	<1.0	Met QA/QC target criteria.	Trip Blank-12	11/08/01	<1.0	Met QA/QC target criteria.
Trip Blank-3	12/04/00	<1.0	Met QA/QC target criteria.	Trip Blank-13	01/30/02	<1.0	Met QA/QC target criteria.
Trip Blank-4	12/06/00	<1.0	Met QA/QC target criteria.	Trip Blank-14	12/01/02	<1.0	Met QA/QC target criteria.
Trip Blank-5	12/08/00	<1.0	Met QA/QC target criteria.	Trip Blank-15	12/04/02	<1.0	Met QA/QC target criteria.
Trip Blank-6	12/11/00	<1.0	Met QA/QC target criteria.	Trip Blank-16	12/08/02	<1.0	Met QA/QC target criteria.
Trip Blank-7	12/12/00	<1.0	Met QA/QC target criteria.	Trip Blank-17	12/11/02	<1.0	Met QA/QC target criteria.
Trip Blank-8	12/14/00	<1.0	Met QA/QC target criteria.	Trip Blank-18	12/15/02	<1.0	Met QA/QC target criteria.
Trip Blank-9	08/27/01	<1.0	Met QA/QC target criteria.	Trip Blank-19	02/22/02	<1.0	Met QA/QC target criteria.
Trip Blank-10	08/28/01	<1.0	Met QA/QC target criteria.	Trip Blank-20	02/23/02	<1.0	Met QA/QC target criteria.

Table G-12. Spike Recovery and Precision Values for Matrix Spike Samples Analyzed During the Steam Pre-Demonstration Soil Sampling

Steam Treatment Plot MS/MSD Samples QA/QC Target Level Recovery % = 70 – 130 % QA/QC Target Level < 25.0 %			Total Number of Soil Samples Collected = 302 Total Number of MS/MSD Samples Analyzed = 16		
Pre-Demonstration					
Sample Date	TCE Recovery (%)	RPD (%)	Sample Date	TCE Recovery (%)	RPD (%)
12/09/00	83	1.5	12/13/00	109	1.3
	88			105	
12/11/00	112	0.20	12/13/00	91	0.99
	113			89	
12/11/00	83	4.4	12/14/00	104	3.2
	96			113	
12/11/00	97	1.3	12/14/00	103	2.6
	94			96	
12/11/00	121	7.3	12/15/00	110	7.0
	101			102	
12/12/00	89	11.0	12/15/00	100	5.3
	47			105	
12/12/00	66	13.0	12/16/00	93	0.34
	113			93	
12/12/00	80	4.2	12/16/00	91	3.0
	91			93	

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Table G-13. Spike Recovery and Precision Values for Matrix Spike Samples Analyzed During the Steam Post-Demonstration Soil Sampling

Steam Treatment Plot MS/MSD Samples QA/QC Target Level Recovery % = 70 – 130 % QA/QC Target Level < 25.0 %			Total Number of Soil Samples Collected = 312 Total Number of MS/MSD Samples Analyzed = 26		
Post-Demonstration					
Sample Date	TCE Recovery (%)	RPD (%)	Sample Date	TCE Recovery (%)	RPD (%)
02/02/02	102	0.0	02/10/02	101	1.0
	102			100	
02/02/02	99.6	11.0	02/12/02	115	4.3
	88.6			110	
02/03/02	104	1.9	02/14/02	100	1.6
	102			98.4	
02/03/02	100	0.0	02/14/02	129	0.0
	100			129	
02/04/02	108	2.8	02/15/02	99.8	4.2
	105			104	
02/04/02	115	1.7	02/15/02	132	6.1
	113			124	
02/04/02	202	17.8	02/16/02	110	0.9
	166			111	
02/05/02	118	0.8	02/16/02	117	0.0
	119			117	
02/06/02	116	2.6	02/19/02	120	0.8
	119			121	
02/07/02	127	12.6	02/21/02	139	0.0
	111			139	
02/08/02	108	2.8	02/25/02	98.8	0.0
	105			98.8	
02/09/02	110	0.0	02/26/02	159	0.0
	110			159	
02/09/02	107	1.9	02/26/02	99.9	0.1
	105			100	

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Table G-14. Spike Recovery Values for Soil Laboratory Control Spike Samples Collected for the Steam Pre-Demonstration

Steam Treatment Plot LCS/LCSD Samples QA/QC Target Level Recovery % = 70 – 130 % QA/QC Target Level < 25.0 %			Total Number of Soil Samples Collected = 302 Total Number of LCS/LCSD Samples Analyzed = 16		
Pre-Demonstration					
Sample Date	TCE Recovery (%)	RPD (%)	Sample Date	TCE Recovery (%)	RPD (%)
12/01/00	98	1.8	12/13/00	95	1.1
	97			96	
12/04/00	91	1.2	12/14/00	93	9.7
	92			102	
12/05/00	93	1.7	12/15/00	103	13.6
	95			89	
12/06/00	96	2.8	12/16/00	105	0.0
	93			105	
12/09/00	107	2.8	12/16/00	105	2.9
	104			102	
12/09/00	101	2.0	12/17/00	94	0.0
	103			94	
12/11/00	112	0.20	12/18/00	113	0.0
	113			113	
12/11/00	94	2.1	12/20/00	104	13.5
	92			90	

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Table G-15. Spike Recovery Values for Soil Laboratory Control Spike Samples Collected for the Steam Post-Demonstration

Steam Treatment Plot LCS/LCSD Samples QA/QC Target Level Recovery % = 70 – 130 % QA/QC Target Level < 25.0 %			Total Number of Soil Samples Collected = 312 Total Number of LCS/LCSD Samples Analyzed = 18		
Post-Demonstration					
Sample Date	TCE Recovery (%)	RPD (%)	Sample Date	TCE Recovery (%)	RPD (%)
01/31/02	97.6	0.7	02/12/02	130	22.3
	98.3			101	
02/02/02	99.8	5.2	02/13/02	119	8.4
	105			109	
02/03/02	100	10.0	02/14/02	102	2.9
	110			105	
02/04/02	107	2.8	02/15/02	105	4.8
	110			100	
02/04/02	113	0.0	02/15/02	103	10.6
	113			114	
02/06/02	118	14.4	02/19/02	114	0.0
	101			114	
02/06/02	118	0.8	02/21/02	102	2.9
	117			105	
02/08/02	106	8.4	0/22/02	103	1.9
	97.1			105	
02/10/02	106	0.9	02/25/02	99.5	0.1
	107			99.6	

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Table G-16. Method Blank Samples Analyzed During the Steam Pre-Demonstration Soil Sampling

Steam Pre-Demonstration Soil QA/QC Samples QA/QC Target Level < 1.0 mg/kg			Total Number of Samples Collected = 302 Total Number of Method Blank Samples Analyzed = 30		
Pre-Demonstration Method Blanks					
Analysis Date	TCE Concentration (mg/kg)	Comments	Analysis Date	TCE Concentration (mg/kg)	Comments
12/01/00	<0.250	Met QA/QC Target Criteria	12/12/00	<0.250	Met QA/QC Target Criteria
12/01/00	<0.250	Met QA/QC Target Criteria	12/12/00	<0.250	Met QA/QC Target Criteria
12/03/00	<0.250	Met QA/QC Target Criteria	12/13/00	<0.250	Met QA/QC Target Criteria
12/03/00	<0.250	Met QA/QC Target Criteria	12/14/00	<0.250	Met QA/QC Target Criteria
12/04/00	<0.250	Met QA/QC Target Criteria	12/15/00	<0.250	Met QA/QC Target Criteria
12/04/00	<0.250	Met QA/QC Target Criteria	12/15/00	<0.250	Met QA/QC Target Criteria
12/05/00	<0.250	Met QA/QC Target Criteria	12/15/00	<0.250	Met QA/QC Target Criteria
12/05/00	<0.250	Met QA/QC Target Criteria	12/16/00	<0.250	Met QA/QC Target Criteria
12/06/00	<0.250	Met QA/QC Target Criteria	12/16/00	<0.250	Met QA/QC Target Criteria
12/07/00	<0.250	Met QA/QC Target Criteria	12/17/00	<0.250	Met QA/QC Target Criteria
12/08/00	<0.250	Met QA/QC Target Criteria	12/18/00	<0.250	Met QA/QC Target Criteria
12/08/00	<0.250	Met QA/QC Target Criteria	12/18/00	<0.250	Met QA/QC Target Criteria
12/09/00	<0.250	Met QA/QC Target Criteria	12/20/00	<0.250	Met QA/QC Target Criteria
12/11/00	<0.250	Met QA/QC Target Criteria	12/20/00	<0.250	Met QA/QC Target Criteria
12/11/00	<0.250	Met QA/QC Target Criteria	12/21/00	<0.250	Met QA/QC Target Criteria

Table G-17. Method Blank Samples Analyzed During the Steam Post-Demonstration Soil Sampling

Steam Pre-Demonstration Soil QA/QC Samples QA/QC Target Level < 1.0 mg/kg			Total Number of Samples Collected = 312 Total Number of Method Blank Samples Analyzed = 28		
Post-Demonstration Method Blanks					
Analysis Date	TCE Concentration (mg/kg)	Comments	Analysis Date	TCE Concentration (mg/kg)	Comments
01/28/02	<0.250	Met QA/QC Target Criteria	02/08/02	<0.250	Met QA/QC Target Criteria
01/28/02	<0.250	Met QA/QC Target Criteria	02/08/02	<0.250	Met QA/QC Target Criteria
01/29/02	<0.250	Met QA/QC Target Criteria	02/11/02	<0.250	Met QA/QC Target Criteria
01/29/02	<0.250	Met QA/QC Target Criteria	02/11/02	<0.250	Met QA/QC Target Criteria
01/30/02	<0.250	Met QA/QC Target Criteria	02/12/02	<0.250	Met QA/QC Target Criteria
01/30/02	<0.250	Met QA/QC Target Criteria	02/12/02	<0.250	Met QA/QC Target Criteria
02/01/02	<0.250	Met QA/QC Target Criteria	02/13/02	<0.250	Met QA/QC Target Criteria
02/04/02	<0.250	Met QA/QC Target Criteria	02/13/02	<0.250	Met QA/QC Target Criteria
02/04/02	>0.250	Met QA/QC Target Criteria	02/13/02	<0.250	Met QA/QC Target Criteria
02/05/02	>0.250	Met QA/QC Target Criteria	02/14/02	<0.250	Met QA/QC Target Criteria
02/06/02	>0.250	Met QA/QC Target Criteria	02/14/02	<0.250	Met QA/QC Target Criteria
02/06/02	>0.250	Met QA/QC Target Criteria	02/15/02	<0.250	Met QA/QC Target Criteria
02/07/02	>0.250	Met QA/QC Target Criteria	02/15/02	<0.250	Met QA/QC Target Criteria
02/07/02	>0.250	Met QA/QC Target Criteria	02/08/02	<0.250	Met QA/QC Target Criteria

Table G-18. Spike Recovery and Precision Values for Matrix Spike Samples Analyzed During the Steam Demonstration Groundwater Sampling

Steam Treatment Plot Groundwater QA/QC (MS/MSD)				Total Number of Samples Collected = 38			
QA/QC Target Level Recovery % = 70 – 130 %				Total Number of Matrix Spike Samples Analyzed = 7			
QA/QC Target Level RPD < 25.0 %				Steam Demonstration Matrix Spike Samples			
Sample ID	Sample Date	TCE Recovery (%)	RPD (%)	Sample ID	Sample Date	TCE Recovery (%)	RPD (%)
0111027-03A MS	11/09/01	98.8	3.5	0202131-03A MS	02/26/02	148	1.6
0111027-03A MSD		95.3		0202131-03A MSD		146	
0111048-02A MS	11/12/01	101	4.7	0202131-08A MS	02/27/02	132	0.8
0111048-02A MSD		96.3		0202131-08A MSD		131	
0111041-04A MS	11/13/01	97.2	5.5	0203129-04A MS	03/28/02	90.7	2.5
0111041-04A MSD		91.9		0203129-04A MSD		88.4	
0111046-01B MS	11/14/01	106	8.5				
0111046-01B MSD		97					

Table G-19. Spike Recovery and Precision Values for Laboratory Control Spike Samples Analyzed During the Pre- and Post-Demonstration Groundwater Sampling

Pre-Demonstration LCS/LCSD Samples				Post-Demonstration LCS/LCSD Samples			
Sample ID	Sample Date	TCE Recovery (%)	RPD (%)	Sample ID	Sample Date	TCE Recovery (%)	RPD (%)
Steam Treatment Plot Groundwater QA/QC QA/QC Target Level Recovery % = 70 – 130 % QA/QC Target Level RPD < 25.0 %				Total Number of Samples Collected = 23 (Pre-) 21 (Post-) Total Number of Matrix Spike Samples Analyzed = 5			
DQMKE1AC-LCS	12/01/00	98	1.8	LCS-9924	02/26/02	99.5	3.1
DQMKE1AC-LCSD		97		LCS-9928		96.5	
DQQ031AC-LCS	12/04/00	91	1.2	LCS-9939	02/28/02	101	0.98
DQQ031AC-LCSD		92		LCS-10179		102	
DQWR31AC-LCS	12/06/00	96	2.8				
DQWR31AC-LCSD		93					

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Table G-20. Spike Recovery and Precision Values for Laboratory Control Spike Samples Analyzed During the Steam Demonstration Groundwater Sampling

Demonstration LCS/LCSD Spike Samples							
Sample ID	Sample Date	TCE Recovery (%)	RPD (%)	Sample ID	Sample Date	TCE Recovery (%)	RPD (%)
Steam Treatment Plot Groundwater QA/QC QA/QC Target Level Recovery % = 70 – 130 % QA/QC Target Level RPD < 25.0 %				Total Number of Samples Collected = 33 Total Number of Matrix Spike Samples Analyzed = 5			
EJ1DK1AC-LCS	09/04/01	99	7.4	LCS-9164	11/09/01	104	3.8
EJ1DK1AC-LCSD		107		LCS-9168		108	
EJ1M61AC-LCS	09/04/01	106	0.14	LCS-9178	11/13/01	107	2.8
EJ1M61AC-LCSD		106		LCS-9187		110	
EJ30H1AC-LCS	09/06/01	95	12.0				
EJ30H1AC-LCSD		107					

Table G-21. Method Blank Samples Analyzed During the Steam Pre-Demonstration Groundwater Sampling

Steam Pre- and Post-Demo Groundwater QA/QC Samples QA/QC Target Level < 3.0 µg/L			Total Number of Samples Collected = 23 (Pre-) 21 (Post-) Total Number of Method Blank Samples Analyzed = 6		
Pre-Demonstration Method Blanks			Post-Demonstration Method Blanks		
Analysis Date	TCE Concentration (µg/L)	Comments	Analysis Date	TCE Concentration (µg/L)	Comments
12/14/00	<1.0	Met QA/QC Target Criteria	03/28/02	<1.0	Met QA/QC Target Criteria
12/15/00	<1.0	Met QA/QC Target Criteria	03/30/02	<1.0	Met QA/QC Target Criteria
12/16/00	<1.0	Met QA/QC Target Criteria	04/01/02	<1.0	Met QA/QC Target Criteria

Table G-22. Method Blank Samples Analyzed During the Steam Demonstration Groundwater Sampling

Steam Demonstration Groundwater QA/QC Samples QA/QC Target Level < 3.0 µg/L			Total Number of Samples Collected = 33 Total Number of Method Blank Samples Analyzed = 8		
Demonstration					
Analysis Date	TCE Concentration (µg/L)	Comments	Analysis Date	TCE Concentration (µg/L)	Comments
09/04/01	<1.0	Met QA/QC Target Criteria	11/09/01	<1.0	Met QA/QC Target Criteria
09/04/01	<1.0	Met QA/QC Target Criteria	11/12/01	<1.0	Met QA/QC Target Criteria
09/06/01	<1.0	Met QA/QC Target Criteria	11/13/01	<1.0	Met QA/QC Target Criteria
09/06/01	<1.0	Met QA/QC Target Criteria	11/14/01	<1.0	Met QA/QC Target Criteria



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DATE: 11/8/01 PAGE 1 OF 2
 PO #: _____ DHL WORK ORDER #: 0111041
 PROJECT LOCATION OR NAME: CCAS
 CLIENT PROJECT #: _____ COLLECTOR: ED, SS

Field Sample I.D.	DHL Lab #	Date	Time	Matrix	Container Type	# of Containers	PRESERVATION					ANALYSES														FIELD NOTES									
							HCl	HNO ₃	H ₂ SO ₄ □ NaOH □	ICE	UNPRESERVED	BTEX □ MIBEL □	TRPH 418.1 □ TPH 1005 □ TPH 1006 □	GASOLINE MOD 8015 □	DIESEL MOD 8015 □	VOC 8260 □ SEE LIST	SVOC 8270 □ PAH 8270 □	8081 PESTICIDES □ 8151 HERBICIDES □	TCLP - METALS (RCRA) □ TCLP VOC □	LEAD - PEST □ HERB □ OTHER VOC □	PCB □ TOTAL □ D.W. 200.8 □ TCLP □	TDS □ TOX □ % MOISTURE □	PH □ HEXAVALENT CHROMIUM □	EXPLOSIVES □ PECTHLORATE □	CHLORIDE □ ANIONS □ ALKALINITY □										
BAT-3S	01A	11/7/01	09:00	W	40 mL v6A	3	X																												SEE LIST FOR
BAT-3I	02A		09:30	W		3	X																												VOCs to be
BAT-3D	03A		10:00	W		3	X																											analyzed.	
PA-20	04A		11:00	W		3	X																												
PA-21	05A		10:30	W		3	X																												
PA-22	06A		14:00	W		3	X																												
PA-14S	07A		15:00	W		3	X																												
PA-14S DUP	08A		15:00	W		3	X																												
PA-14I	09A		15:30	W		3	X																												
PA-14D	10A		16:00	W		3	X																												
PA-18S	11A		16:30	W		3	X																												
PA-18I	12A		17:00	W		3	X																												
PA-18D	13A	↓	17:30	W		3	X																												
Trip Blank	14A	11/8/01	10:00	W	↓	2	X																												
Ringsate-1	15A	11/7	8:30	W	↓	0	X																												

RELINQUISHED BY: (Signature) <i>Ed D...</i>	DATE/TIME 11/8/01 10:00	RECEIVED BY: (Signature) <i>Fed Ex</i>	TAT RUSH <input type="checkbox"/> CALL FIRST 1 DAY <input type="checkbox"/> CALL FIRST 2 DAY <input type="checkbox"/> NORMAL <input checked="" type="checkbox"/> OTHER <input type="checkbox"/>	LABORATORY USE ONLY: RECEIVING TEMP: <u>2.2</u> , 1.6 °C CUSTODY SEALS - <input type="checkbox"/> BROKEN <input type="checkbox"/> INTACT <input checked="" type="checkbox"/> NOT USED CARRIER BILL # <u>Fed Ex 823984123806</u> <input type="checkbox"/> PICKED UP BY DHL ANALYTICAL STAFF <input type="checkbox"/> HAND DELIVERED
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